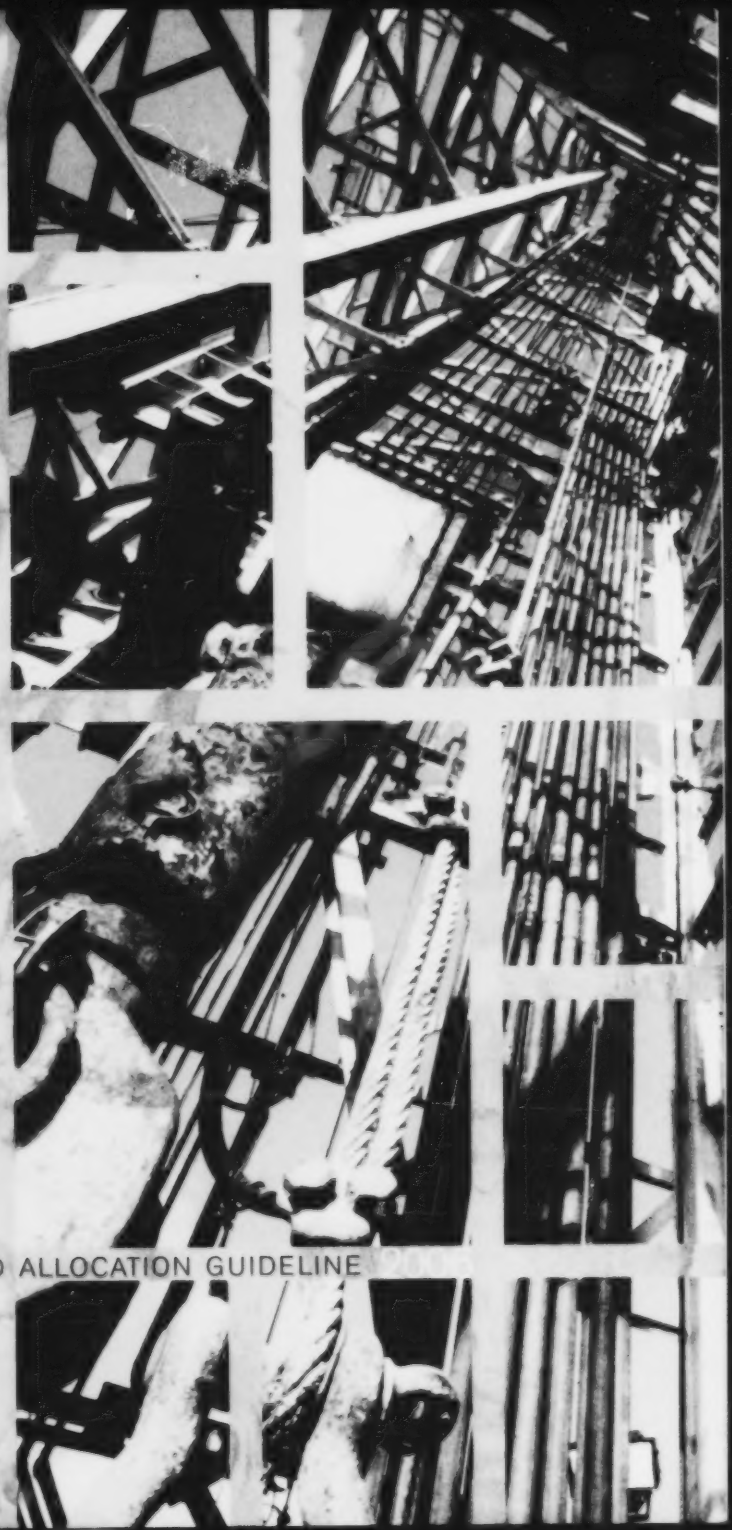

WATER CONSERVATION AND ALLOCATION GUIDELINE

Alberta

106-06786/

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Water Conservation and Allocation Guideline for Oilfield Injection (2006)

The purpose of this guideline is to support the conservation and management of water and to prevent excess use of water during enhanced recovery of hydrocarbon resources.

The glossary in Appendix F defines technical terms and acronyms.

introduction:

This document provides direction for regulatory agencies and developers where the use of non-saline water resources may be essential to an Enhanced Recovery (ER) Scheme.

The Guideline uses a systems approach to achieve specific environmental outcomes that support the *Water Conservation and Allocation Policy for Oilfield Injection* and the goals of *Water for Life: Alberta's Strategy for Sustainability*.

This Guideline applies to ER Schemes in Alberta that use non-saline water as a water source, including:

- Licence renewal applications for projects already operating and licensed to use non-saline water resources.
- New licence applications for oilfield injection use of non-saline water.

Holders of permanent licences (issued under the *Water Resources Act*) are encouraged to cooperate with the intent of the *Water Conservation and Allocation Policy for Oilfield Injection* and the goals of *Water for Life: Alberta's Strategy for Sustainability*.

Alberta Environment will approach all holders of permanent licences to request a voluntary review of their licence, prior to 2008, using this Guideline as a point of reference.

guideline purpose and objectives:

This Guideline provides information regarding:

- Recommended water conservation practices in the design and operation of ER projects.
- Application requirements to obtain a *Water Act* licence for the use of non-saline water resources.

Regulatory procedures and application steps are outlined in Part C of the Guideline.

Overall objectives of the Guideline:

1. WATER CONSERVATION – to minimize the use of non-saline water use while limiting stranding of oil resources, including:
   - **Eliminating (on a case-by-case basis)** the use of non-saline water in ER projects where reasonable and feasible alternatives exist.
   - **Identifying water-short areas**, where the maximum effort must be made to find alternatives to non-saline water.
   - **Reducing** the use of non-saline water for existing ER projects through *periodic re-evaluation* of alternatives and *continuous improvement* efforts.
2. REGULATORY CONSISTENCY – to provide information to operators, regulators and the public regarding feasible options and recommended approaches to reducing non-saline water use.
3. RIGOROUS TECHNICAL EVALUATION – to provide guidance for technical evaluations, industry practices and regulatory decisions.
4. ADAPTABILITY – to enable regulatory discretion and adaptation to local and regional circumstances (environmental and geological variability).
5. IMPROVED PRACTICES – to encourage water conservation, continuous improvement, shared responsibility and the use of flexible tools to reduce non-saline water use, including actions to:
   - **Increase productivity** of non-saline water use by implementing *recycling, reuse* and *tertiary ER methods* to maximize the amount of oil recovered for each barrel of non-saline water used.
   - **Protect the aquatic ecosystem, non-saline groundwater resources and other water users** through water conservation, adaptive management and adoption of environmental stewardship measures.

guideline **format:**

The Guideline is divided into six topics ranging from broad water management concepts to the specific steps required in preparing an application for a water use licence.

PART A – Outcomes and environmental management for oilfield injection water use in the context of *Water for Life: Alberta's Strategy for Sustainability*.

PART B – The Policy for the allocation of water for oilfield injection, and the operational policy to maintain a consistent approach to water allocation.

PART C – Regulatory procedures (Policy implementation and delivery), including the regulatory process "decision tree" and water licence application requirements.

PART D – Monitoring and reporting requirements to improve evaluation of water use practices.

PART E – Initiatives to review and update the Policy and Guideline (2007-2008).

PART F – Complementary (non-regulatory) initiatives to address water conservation and research initiatives as recommended by the Advisory Committee on Water Use Practice and Policy.

part – outcomes:

1.0 OVERVIEW

Outcomes for environmental management include:

- Broad outcomes for society
- Policy and sectoral outcomes
- Place-based and project specific outcomes

Environmental outcomes form the basis for "sustainable resource and environmental management systems" including policy objectives, regulatory procedures, monitoring and reporting requirements, continuous improvement efforts and other actions that will support environmental outcomes.

Figure 1 shows the hierarchy of environmental management tools and outcomes relevant to oilfield injection. The management tools and outcomes used for oilfield injection projects can be categorized as follows:

1. *Water for Life* goals and Government of Alberta policy
2. Environmental policy and outcomes (Alberta Environment)
3. Place-based and site-specific objectives

Water for Life and Government of Alberta policy

Societal outcomes, such as reliable quality water supplies for a sustainable economy, are discussed in *Water for Life: Alberta's Strategy for Sustainability*[1]. The strategy defines three outcomes for society in managing of our water resources:

- Reliable quality water supplies for a sustainable economy.
- Healthy Aquatic Ecosystems.
- Safe, Secure Drinking Water Supplies.

Environmental policy and outcomes (Alberta Environment)

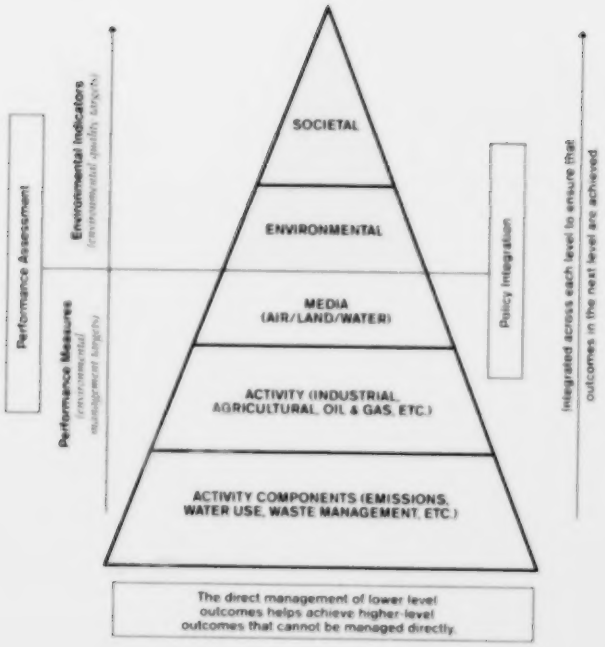
Policy-based outcomes and goals specific to the oilfield injection sector are discussed in the *Advisory Committee on Water Use Practice and Policy Final Report* (August 2004) and the *Water Conservation and Allocation Policy for Oilfield Injection* (2006). The Sustainable Resource and Environmental Management System, outlined in Section 1.1 (and Appendix D), establishes specific outcomes for oilfield injection that support the societal outcomes established in the water strategy.

Place-based and site-specific objectives

Outcomes and goals specific to basins across Alberta are discussed in individual water management plans. *Water Act* licences may also specify targets and conservation measures to meet specific objectives for a particular project.

1 *Water for Life: Alberta's Strategy for Sustainability* is available at: www.waterforlife.gov.ab.ca

Figure 1.
Outcome Hierarchy


SOCIETAL
ENVIRONMENTAL
MEDIA (AIR/LAND/WATER)
ACTIVITY (INDUSTRIAL, AGRICULTURAL, OIL & GAS, ETC.)
ACTIVITY COMPONENTS (EMISSIONS, WATER USE, WASTE MANAGEMENT, ETC.)
Performance Assessment
Environmental Indicators
(environmental quality targets)
Performance Measures
(environmental management targets)
Policy Integration
Integrated across each level to ensure that outcomes in the next level are achieved.
The direct management of lower level outcomes helps achieve higher-level outcomes that cannot be managed directly.

1.1 SUSTAINABLE RESOURCE AND ENVIRONMENTAL MANAGEMENT SYSTEM OUTCOMES

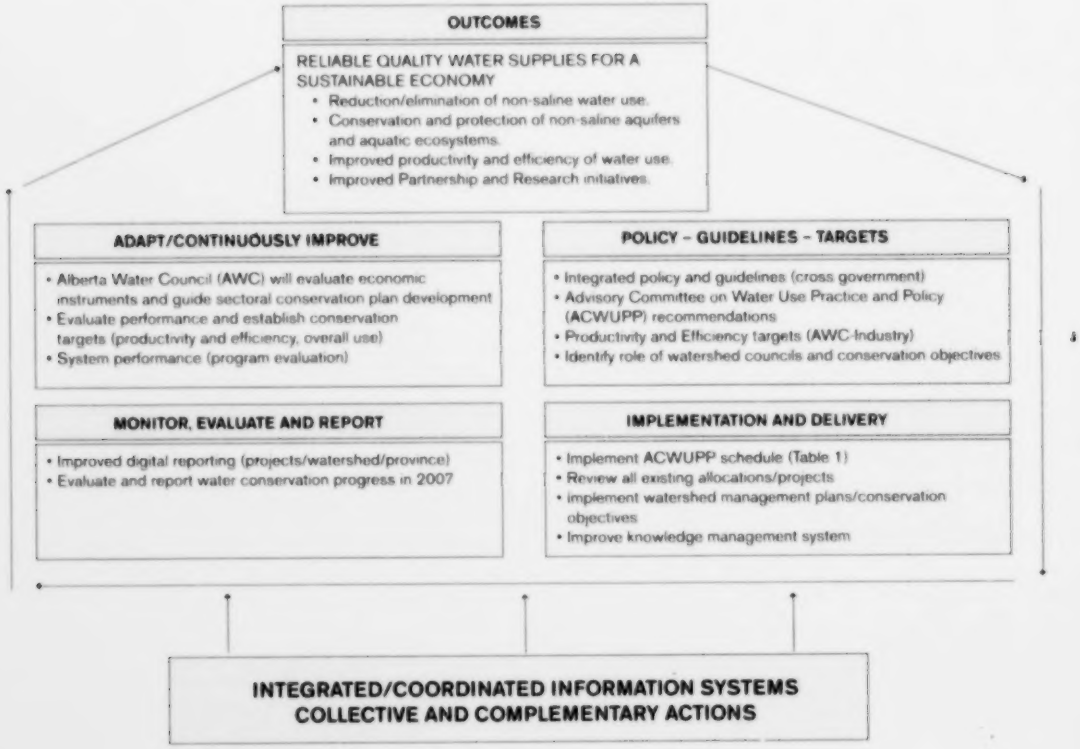
The Sustainable Resource and Environmental Management System (SREM) for Oilfield Injection (Figure 2) sets outcomes and targets for the 2004-2007 period including:

- Reliable quality water supplies for a sustainable economy.
- Reduction or elimination (on a case-by-case basis) of non-saline water use.
- Improved productivity and efficiency of water use.
- Conservation and protection of non-saline aquifers and aquatic ecosystems.
- Improved partnership and research initiatives.

This Guideline outlines regulatory procedures to achieve these outcomes.

ER project operators and applicants for water use licences need to be familiar with the broad objectives and outcomes described in this section in order to fulfill their responsibilities for the wise use of water in Alberta.

Figure 2.
Sustainable Resource and Environmental Management System for Oilfield Injection


OUTCOMES
RELIABLE QUALITY WATER SUPPLIES FOR A SUSTAINABLE ECONOMY
• Reduction/elimination of non-saline water use.
• Conservation and protection of non-saline aquifers and aquatic ecosystems.
• Improved productivity and efficiency of water use.
• Improved Partnership and Research initiatives.
ADAPT/CONTINUOUSLY IMPROVE
• Alberta Water Council (AWC) will evaluate economic instruments and guide sectoral conservation plan development
• Evaluate performance and establish conservation targets (productivity and efficiency, overall use)
• System performance (program evaluation)
POLICY – GUIDELINES – TARGETS
• Integrated policy and guidelines (cross government)
• Advisory Committee on Water Use Practice and Policy (ACWUPP) recommendations
• Productivity and Efficiency targets (AWC-Industry)
• Identify role of watershed councils and conservation objectives
MONITOR, EVALUATE AND REPORT
• Improved digital reporting (projects/watershed/province)
• Evaluate and report water conservation progress in 2007
IMPLEMENTATION AND DELIVERY
• Implement ACWUPP schedule (Table 1)
• Review all existing allocations/projects
• implement watershed management plans/conservation objectives
• Improve knowledge management system
INTEGRATED/COORDINATED INFORMATION SYSTEMS
COLLECTIVE AND COMPLEMENTARY ACTIONS

part – policy:

2.0 POLICY DIRECTION

The *Water Conservation and Allocation Policy for Oilfield Injection* document provides direction regarding oilfield injection regulation and water conservation. *Water for Life: Alberta's Strategy for Sustainability* provides additional guidance on water conservation objectives that applies to this Guideline. The *Advisory Committee on Water Use Practice and Policy Final Report* provides specific recommendations and a schedule for changes to current practices and procedures in the enhanced recovery sector.

2.1 OPERATIONAL POLICY

Applying the Guideline

This Guideline applies across Alberta, including both agricultural (White Area/Private Land) and non-agricultural (Green Area/Public or Crown Land) regions.

The specific requirements of this Guideline, and provisions of the *Water Conservation and Allocation Policy for Oilfield Injection*, may vary in some areas of the province, based on existing or future watershed management plans, or Approved Water Management Plans. These plans provide direction regarding water allocation, conservation objectives, and related water management issues.

Groundwater

Quantity Limitations: Groundwater

An applicant that proposes to use non-saline groundwater for underground (oilfield) injection will be restricted to a maximum of one-half of the long-term yield of a given aquifer in the immediate vicinity of the water source well. This will be accomplished by limiting drawdown in the production aquifer, as measured in an observation well at a distance of 150 metres from the production well, to 35 per cent during the first year of operation and no more than 50 per cent over the life of the project.

Surface Water

Quantities of surface water available for licensing may be limited by requirements for conservation objectives, environmental flows, approved water management plans, Crown reservations, trans-boundary apportionment agreements, previous licences or other factors. Water management plans and approved water management plans may restrict the use of water for oilfield injection or require place-based conditional requirements in licences (contingency measures, minimum flow restrictions, etc.).

Cumulative Effects

Applicants must evaluate the combined effects of their proposed water use and the water use of other water diversions (surface water and groundwater) in the area.

The evaluation must determine the cumulative effects on the aquatic environment and existing water users that will result from all diversions within the geographical area where the applicant's water use will add a significant incremental impact.

Cumulative effects assessments are discussed in Section 3.2.5.

Water-short and Potentially-water-short Areas

Applicants must maximize efforts to replace non-saline water use in water-short areas of Alberta.

Water-short areas occur where natural conditions and/or development pressures limit the availability of surface water and groundwater for future sustainable development and the protection of the aquatic environment. Water-short areas are identified on an interim water-short areas map, or through assessment of water-short and potentially-water-short areas in individual water management plans.

Water-short areas are discussed in Section 3.2.8 and in Appendix B.

Risk-based Assessment

Applicants must assess environmental risks according to a three-tier classification system. The assessment includes a requirement for evaluation of water conservation options in all projects (throughout the province) and planning for replacement of non-saline water sources in water-short areas.

Terms of the Licence (new and renewal)

If the Director decides to issue a licence, the term will be for a two-year period. Upon application for renewal, if the Director allows the renewal, the licence will be issued for a term of five years.

Water Act term licences to continue projects previously issued water diversion "temporary permissions" (under the *Water Resources Act*) will be issued for a five-year term, or for the remaining project life, if less than five years. This applies to temporary permissions issued before January 1, 1999 and expiring on December 31, 2006.

Under the *Water (Ministerial) Regulation*, AENV Approvals Managers (or "Directors") may change the renewal term.

The applicable term recommended by this Guideline will be reviewed during the 2007-2008 program review and may be changed at that time.

Renewal Applications

Licence holders must apply for renewal as specified in the *Water Act*. This Guideline sets the minimum requirements for a renewal application. The Director may require further information.

Allocations may be reduced at renewal. Licence holders will be consulted when allocation reductions are being considered. Conditions of the licence will also be taken into consideration.

New terms and conditions of the renewal licence may be established if the Director considers it appropriate.

A review of alternate water source availability and progress towards reduction of the use of non-saline water will be required as an essential component of each five-year term renewal application.

Water Conservation Incentives and Application Exceptions

Recognizing that water conservation is an ongoing effort, and many ER projects have already initiated water conservation measures, reduced evaluation may be allowed for renewal of ER projects that are already conserving water.

Projects that have demonstrated significant progress towards meeting *Water for Life* conservation goals in the previous five-year period may apply for a licence renewal based on a concise economic and environmental evaluation (see sections 3.2.4 and 3.2.6).

It is expected further water conservation measures will proceed in the subsequent renewal period if the review shows additional water conservation gains are reasonable and practical.

This water conservation incentive applies to the following projects (renewals):

- Tier 1[2] licence renewals for ER projects which have reduced their non-saline water requirements by more than 30 per cent (relative to actual use in the previous term).
- Tier 1 licence renewals for ER projects which have increased resource productivity and efficiency[3] by more than 30 per cent (relative to productivity and efficiency in the previous term).
- Tier 2 ER projects that are not in "water-short[4] " or "potentially-water-short" areas (see Figure 10, Appendix B), are at the discretion of the AENV Director. Projects must have reduced their non-saline water requirements, or increased resource efficiency, by more than 30 per cent (relative to the actual use in the previous term).

NOTE: Licence renewal applicants must still consider new saline water sources or other alternatives in the vicinity that have become available during the previous term.

The Approvals Manager (or "Director") responsible for evaluating a licence renewal application may, on a case-by-case basis, consider historical water conservation improvements (more than five years in the past) when determining the level of assessment required. In some cases, the most feasible water conservation measures may have been implemented under previous water conservation initiatives. However, in all circumstances, a review of changing conditions and options over time is warranted.

Application Exemptions in Special Circumstances

Section 3.2.4 discusses limited circumstances in which a rigorous economic evaluation is not useful in making appropriate water management decisions. Technical evaluation criteria may also be reduced in some circumstances, at the discretion of the AENV "Designated Director" (Approvals Manager).

2 Tier 1 and Tier 2 projects are described in section 3.2.2 of this guideline.
3 "Resource productivity and efficiency" is the volume of water use relative to the volume of oil (hydrocarbons) produced.
4 "Water-short" areas are described in Appendix B.

Exemption to evaluation requirements may occur under the following circumstances:

- Licences for ongoing schemes with a remaining life expectancy of less than five years. Licences will be issued for a reduced term (the remaining project life) with non-renewal conditions.
- Licences for new ER pilot-type projects that require relatively small volumes of non-saline water for a short (two to four-year) period[5].

NOTE: Although a rigorous economic and technical evaluation is not expected for these "exempt" projects, it is expected the operator will still use saline sources or other alternatives if available.

With the exception of the general guidance in this section on **Water Conservation Incentives and Application Exceptions**, it is essential that environmental impacts of projects be addressed in every application for a water diversion licence. The AENV Director may request additional information, if needed, to evaluate any licence or renewal application.

Licence Conditions

The Director will include terms and conditions in the licence to satisfy the intent of the *Water Conservation and Allocation Policy for Oilfield Injection* and the *Water Act*.

Terms and conditions of the licence (including allocation) may be set when the licence is renewed at the initial two-year expiry, or at any subsequent five-year term renewal (under sections 59, 60 and 61 of the *Water Act*). Amendments to licence conditions may occur at other times in accordance with the *Water Act (s. 54)*.

Economic Evaluations

All new applications must include information on the economic aspects of the alternative water source options. As indicated in the Tier Evaluation Criteria (section 3.2.2) either a Screening Level Review or an Authorization For Expenditure (AFE) Level Review will be required.

Economic costs must be balanced against environmental impacts and the benefits of water conservation efforts. Although it is a general objective to achieve maximum water conservation without stranding oil and gas resources in Alberta, stranding may occur in some water-short areas.

Circumstances in which economic considerations may limit ER development (in combination with water shortages or major environmental risks) are discussed in Section 3.2.2.

5 The scale of pilot-type projects varies, but projects are expected, typically, to use less than 1,000 m³/d for application of this provision.

part – implementation and delivery:

3.0 OVERVIEW

Essential Regulatory Steps

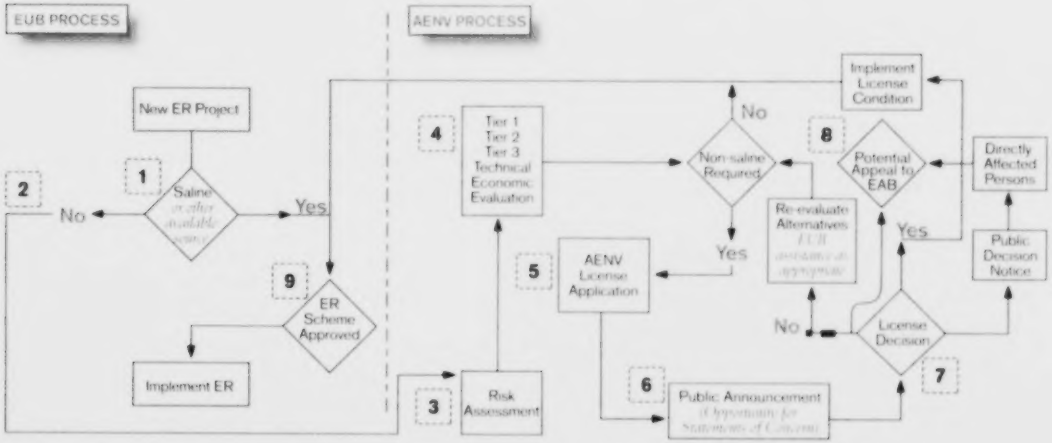
The essential steps for "authorization" of any ER scheme include:

- **Technical Evaluation by Industry** (ER Scheme and alternate water source or non-water technology)
- **Industry Application to AENV** for non-saline water licence.
- **AENV application review and Licence decision** (includes EUB, Industry and public stakeholder consultation).
- **EUB Decision and Authorization of ER Scheme**, after AENV issues a licence.

3.1 REGULATORY PROCESS "DECISION TREE"

Figure 3 shows the regulatory process, outlining the different pathways an application may follow. The decision tree outlines the steps needed to complete an application, and obtain a *Water Act* licence.

Figure 3.
Application Regulatory Process



Please refer to EUB Directive 65, or contact the EUB, for further information on EUB requirements for approval of ER Schemes.

Step 1 – Initial ER Evaluation

Industry will evaluate new ER projects based on economic and technical feasibility. The identification and selection of alternatives to non-saline water use is discussed in Section 3.2.3.

Step 2 – ER Projects Using Saline Water Sources

The regulatory process is shortened if project evaluation indicates that only saline water is needed. An ER application to the EUB is still required, however a *Water Act* application is not needed (the use of saline water resources is exempt from *Water Act* licensing requirements).

An EUB Approval is not required for saline water use, however an Approval is required from the EUB for overall operation of the ER project. Further information regarding the EUB approval process is available from the EUB (EUB Directive 65).

If non-saline water is not needed at the ER project then steps 3-8 are not applicable to the project (see Figure 3), and AENV is not involved in the regulatory process.

Step 3 – Risk Assessment

The risk-based Tier selection process for evaluating non-saline water options is described in Section 3.2. This evaluation will assist in assessing alternatives in high-risk areas.

Applicants should initially review project engineering options and regulatory requirements (including EUB directives, the *Water Act*, AENV policy, Water Management Plans, *Water for Life: Alberta's Strategy for Sustainability* and other relevant government information). A list of regulatory documents relevant to water conservation and sustainable development is provided in Appendix C.

Step 4 – Tiered Technical, Economic and Environmental Evaluation

The application to AENV must contain a detailed environmental, engineering and economic assessment of alternatives. Water conservation options must be assessed to minimize the use of non-saline water throughout the project life. Assessment of alternatives to minimize non-saline water use in the project's initial term must also be assessed.

Reports must also be prepared detailing the investigations and results with respect to the availability of non-saline water and the potential impacts of the proposed water use. Application reports must evaluate impacts on the aquatic environment, local existing water supplies, local water users, and cumulative effects on the watershed resulting from the project. Applications for licensing the use of non-saline groundwater must be accompanied by a report prepared in compliance with AENV's *Groundwater Evaluation Guideline* (2003)[6].

TIER SELECTION DECISIONS

The AENV Director will ultimately evaluate the environmental and economic criteria (with EUB assistance, if requested) and select the relevant "Tier" with requirements appropriate to each project (step 7). The Director will advise the applicant if additional information is required during the licence review.

6 Groundwater Evaluation Guideline (2003) www.gov.ab.ca/env/water/Legislation/Guidelines/GroundwaterEvaluation.pdf

It is the responsibility of applicants to evaluate projects and prepare an application based on an assessment of the environmental risks associated with the project. Applicants should verify the level of technical, economic and environmental evaluation to be conducted, based on the risk assessment, in order to provide the necessary information for regulatory decisions. Initial consultation with AENV staff is recommended during this step.

Evaluating of risks, and determining appropriate Tier level (1, 2 or 3) for a project must be carried out for each application, including renewal applications. Changes in Tier level may occur over the life of the project.

Step 5 – *Water Act* Licence Application

An application must be made to an AENV regional office if non-saline water resources are needed to begin an ER project, or to continue non-saline water use at the term renewal of a *Water Act* licence. Contact information and a map of AENV administrative regions is shown in Appendix A.

The application must include:

- An application form with project and licensee information[7].
- A description of the project and water use anticipated throughout the project life.
- A technical assessment of the feasibility of alternatives to non-saline water use.
- A review of alternate water source availability, and progress towards reduction of the use of non-saline water for each five-year term renewal application.
- An economic assessment of the options for water use at the project, and assessment of non-water ER options.
- An environmental net effects assessment.
- A report describing the proposed non-saline water source, the natural variability and supply constraints of the source, and the existing use of the water source. Applications for groundwater use must include a report completed in compliance with the Groundwater Evaluation Guideline[8].
- An evaluation of the cumulative effects of the proposed water use and the water use of other water diversions in the area.
- An evaluation of environmental impacts and mitigation plans consistent with the scale of the project and the extent of potential impacts.

Further direction regarding information required for applications is provided in Section 3.2. Applicants are advised to consult with AENV staff during preparation of applications.

Step 6 – Public Notice and Public Review

The *Water Act* requires public notice be given for new applications and term-renewal applications, as a minimum requirement.

A newspaper advertisement is prepared by AENV staff and must be published by the applicant to inform water users who might be directly affected by the project. Individuals, corporations or groups who may be directly affected by the project have an opportunity to respond to the advertisement, and provide written "statements of concern" to Alberta

7 Application forms are available at: www.gov.ab.ca/env/water/legislation/Approvals_Licences/WAApplication.doc
8 The Groundwater Evaluation Guideline is available at: www.gov.ab.ca/env/water/Legislation/Guidelines/GroundwaterEvaluation.pdf

Environment. The Director may also require other forms of public notice be provided.

The Director may require that a public review[9] be conducted for renewal applications or licence transfers (including opportunity for direct input from members of the public). The Director will inform the applicant of the specific review requirements if a public review is expected.

"Statements of concern" must be considered by AENV and the applicant during the application review. Applicants should be prepared to provide additional information and documentation to local residents. Applicant responses to "statements of concern" include meetings with individual residents or groups of residents, and/or written communications (information letters, etc.). The applicant can incorporate modifications to a project into the application that satisfy local concerns and the needs of the project.

AENV staff will provide information to applicants and members of the public during public consultation, on request.

Step 7 – Licence Decision

The AENV Director will review the application submitted in accordance with the *Water Conservation and Allocation Policy for Oilfield Injection Purposes*, relevant Guidelines, Water Management Plans, and the *Water Act*. The Director may request the assistance of the EUB in the review of alternate sources.

The Director may request additional information from applicants, and may meet with the applicant to clarify information or the tier selection for the project.

The Director will decide whether a licence will be issued or not, and will determine the terms and conditions for any licence issued.

If the project requires that an EIA be conducted, a decision on issuing a *Water Act* licence will not be finalized until a "public interest" decision is made by the EUB. The regulatory process used in evaluation of EIAs is separate from the process described in this guideline. The specific terms of reference of an EIA (developed individually for each project EIA) specify the environmental evaluation required by AENV. Further information on EIA procedures is available at www.gov.ab.ca/env/protenf/assessment/index.

Step 8 – Environmental Appeals Board

The Environmental Appeals Board (EAB) is an independent board established by the Government of Alberta to hear appeals, as mandated by the *Environmental Protection and Enhancement Act* and the *Water Act*.

The EAB does not become involved in the regulatory process unless a "directly affected person," or the applicant, files an appeal within 30 days of a *Water Act* licence being issued or rejected.

Applicants may appeal the rejection of a licence application, licence conditions imposed, or other matters regarding the licence to the board, after the licence decision has been finalized and a "notice of decision" has been issued.

Further information regarding EAB procedures is available directly from the EAB[10].

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9 Appendix D of the Administrative Guideline for Transferring Water Allocations contains an example of public review requirements. www.gov.ab.ca/env/water/legislation/Guidelines/Transfer_Guidelines.pdf

10 EAB contact information is provided in Appendix A.

Step 9 – ER Scheme Approval

The final step in the regulatory process is Approval of the ER scheme by the EUB. ER schemes may be modified during project operations by re-applying to the EUB.

3.2 TIERED TECHNICAL, ECONOMIC AND ENVIRONMENTAL EVALUATION REQUIRED FOR LICENCE APPLICATIONS AND RENEWAL APPLICATIONS

Risk Based Categories and Regional Considerations

A key aspect of the Guideline is identification of three categories (or "Tiers") of increasingly intensive requirements for investigation of alternate ER fluids or ER methods. A more rigorous evaluation is required for Tier 2 and Tier 3 projects, depending on the degree of water shortage and development pressure in the area. This place-based categorization includes technical, social, environmental and economic criteria.

In general terms, the Tiers can be described as:

TIER 1: Small-scale projects in isolated areas of the province. The areas should have minimal water shortage or development pressure issues.

TIER 2: Large-scale projects, including thermal ER projects, in any area of the province, and all small projects in areas with development and water allocation pressures (i.e. potentially water short areas).

TIER 3: All projects in river basins or aquifer systems with a history of water shortages and existing (or predicted) water allocation limitations (i.e. water-short areas).

A detailed description of the Tier evaluation criteria is provided in Section 3.2.2.

To assure the three goals of *Water for Life* are protected, the applicant must follow the risk based process to select the appropriate Tier for the proposed project evaluation.

3.2.1 RISK BASED TIER SELECTION GUIDE

Step 1 – Risk Based Tier Selection –

Assess how the project/application will impact water resources

Water for Life Goals:

	Safe, Secure Drinking Water Supply	Healthy Aquatic Ecosystems	Reliable, Quality Water Supplies for Sustainable Economy
Major Impact	• Measurable supply effects up to 10 km • Community-level supply constraints	• Multiple cumulative effects • Measurable permanent effect • Instream flow needs not met	• Extensive development pressure • Many competitors for supply
Moderate Impact	• Measurable supply effects up to 1 km • Localized supply constraints (with provision for alternate supplies)	• Few cumulative effects • Measurable reversible effect • Instream flow needs not met at certain (non-critical) times of the year • Aquatic ecosystem remains healthy and productive	• Moderate development pressure • Few competitors for supply
Minor Impact	• Measurable supply effects up to 0.5 km • Negligible supply constraints	• Minor cumulative effect • Minor measurable effect • Instream flow needs always met	• Minimal development pressure • Little competition for supply

Water for Life Goals:

	Safe, Secure Drinking Water Supply	Healthy Aquatic Ecosystems	Reliable Quality Water Supplies for a Sustainable Economy
Major Impact	• Measurable supply effects up to 10 km • Community-level supply constraints	• Multiple cumulative effects • Measurable permanent effect • Instream flow needs not met	• Extensive development pressure • Many competitors for supply
Moderate Impact	• Measurable supply effects up to 1 km • Localized supply constraints (with provision for alternate supplies)	• Few cumulative effects • Measurable reversible effect • Instream flow needs not met at certain (non-critical) times of the year • Aquatic ecosystem remains healthy and productive	• Moderate development pressure • Few competitors for supply
Minor Impact	• Measurable supply effects up to 0.5 km • Negligible supply constraints	• Minor cumulative effect • Mirror measurable effect • Instream flow needs always met	• Minimal development pressure • Little competition for supply

Assess the probability of selected impact(s)

A Remote	B Unlikely	C Likely
• Practically impossible • Occurrence of 1 in 100 years or less	• Conceivable, but very unusual • Occurrence between 1 to 10 in 100 years	• Would happen often • More than 10 occurrences in 100 years

In assessing the appropriate impact and probability ratings, the applicant will provide reasons that support the ratings selected for the proposed project. The criteria specified in the probability rating tables are intended to differentiate levels of impact and probability in broad terms that represent generally accepted criteria. The applicant's specific information will provide supporting reasons for the rating selection.

Plot the impact and probability ratings to determine the Tier level.

Impact Rating				
	3 [Major]	Tier 2	Tier 3*	Tier 3
	2 [Moderate]	Tier 1	Tier 2	Tier 2
	1 [Minor]	Tier 1	Tier 1	Tier 1
		A [Remote]	B [Unlikely]	C [Likely]
		Probability Rating		

Applicants may apply with Tier 2 unless if a site-specific risk assessment indicates that a Tier 3 classification is appropriate.

Information regarding water supply availability should be reviewed with the risk assessment. Water Management Plans may include assessments of current and future water supply availability. Appendix B includes an assessment of "water short" and "potentially water-short" areas, including information on natural and administrative restrictions on available water supply. AENV regional offices can provide additional information.

The responsible AENV Director will review the applicant's impact and probability assessment and supporting reasoning during application review to confirm the Tier level selected.

Complete a Licence Application for the Selected Tier Level

A water allocation licence application will provide the information requested in the following Tier criteria tables. Each table contains additional guidance for the applicant.

This section specifies the information that will be provided in the application for each of the three Tiers. In addition, the Director must consider all of the requirements specified in Section 51 of the *Water Act*. The Director may require additional information to support decisions regarding the application.

Step 2 – Risk Based Tier Selection –

Assess the probability of selected impact(s)

A Remote	B Unlikely	C Likely
• Practically impossible • Occurrence of 1 in 100 years or less	• Conceivable, but very unusual • Occurrence between 1 to 10 in 100 years	• Would happen often • More than 10 occurrences in 100 years

In assessing the appropriate impact and probability ratings, the applicant will provide reasons that support the ratings selected for the proposed project. The criteria specified in the probability rating tables are intended to differentiate levels of impact and probability in broad terms that represent generally accepted criteria. The applicant's specific information will provide supporting reasons for the rating selection.

Step 3 – Risk Based Tier Selection –

Plot the impact and probability ratings to determine the Tier level

Impact Rating				
	3 [Major]	Tier 2	Tier 3*	Tier 3
	2 [Moderate]	Tier 1	Tier 2	Tier 2
	1 [Minor]	Tier 1	Tier 1	Tier 1
		A [Remote]	B [Unlikely]	C [Likely]
		Probability Rating		

* *Applicants may apply with Tier 2 criteria if a site-specific risk assessment indicates that a Tier 2 classification is appropriate.*

Information regarding water supply availability should be reviewed with the risk assessment. Water Management Plans may include assessments of current and future water supply availability. Appendix B includes an assessment of "water-short" and "potentially-water-short" areas, including information on natural and administrative restrictions on available water supply. AENV regional offices can provide additional information.

The responsible AENV Director will review the applicant's impact and probability assessment and supporting reasoning (during application review) to confirm the Tier level selected.

Step 4 – Risk Based Tier Selection –

Complete a Licence Application for the Selected Tier Level

A water allocation licence application will provide the information requested in the following Tier criteria tables. Each table contains additional guidance for the applicant.

3.2.2 TIER EVALUATION CRITERIA

This section specifies the information that will be provided in the application for each of the three Tiers. In addition, the Director must consider all of the requirements specified in Section 51 of the *Water Act*. The Director may require additional information to support decisions regarding the application.

TIER 1

Goal:	Conservation and wise use of water
General Requirements	A description of the ways the proposed project is maximizing water recycling.
Project Scale[11]	Typically an allocation should be less than 450 m^3/d.
Typical Projects	• Smaller-scale ER projects in the "Green Area" of Alberta. • Minimal water shortage, cumulative effects or development pressure issues. • Projects in "not regionally water-short" areas based on the interim "water-short areas" map, unless a site-specific evaluation indicates a Tier 2 classification is appropriate.
Technical Aspects – Evaluation of technical alternatives to non-saline water use	Provide information on: Saline sources (see 3.2.3 for further details) • Rigorous evaluation and testing of saline sources within a minimum 5 km radius. • Review well logs and conduct flow tests as appropriate. • Review availability of produced water (including sources from other area operators). • Water recycling is the expected industry practice/norm in all cases. • Seek saline produced water for all or partial needs • Document alternatives that were considered.
Economic Aspects	Provide screening level economic information, as described in the economics section (3.2.4), for all technical options considered. Water conservation measures, such as pipeline construction and drilling of new saline water source wells may entail additional costs relative to the lowest cost non-saline water source option.
Net Environmental Effect Aspects	Provide screening level information of the positive and negative environmental aspects, as described in section 3.2.6, for all technical options considered.

Explanatory Notes – Tier 1

Where special circumstances indicate that impacts may be significant, the AENV Director responsible for the review of the project may decide a Tier 2 classification is appropriate.

11 Figure 12 (Appendix E) shows the range of project water uses, based on 2001 data. Approximately 80 per cent of applications are expected to use Tier 1 criteria.

TIER 2

Goal	Reduced non-saline water use for ER, increased availability of non-saline water to enable economic growth, and protection of the aquatic environment.
General Requirements	A description of the ways this proposed project is maximizing water recycling.
Project Scale[12]	The use of Tier 2 criteria is typically appropriate for projects using more than 450 m^3/d. Larger isolated projects may be considered Tier 1 at the discretion of the Director in some circumstances (i.e. abundant natural runoff, minimal development pressure, undeveloped area, "minor" environmental risks)[13].
Typical Projects	• Large ER and in-situ projects, and all projects in developed areas. • Potential water shortage, cumulative effects or development pressure issues. • All projects in "potentially water-short" areas based on the interim "water-short areas" map. • Direct competing water users.
Technical Aspects – Evaluation of technical alternatives to non-saline water use	As in Tier 1 as well as: • Increased search to minimum 10 km radius for saline water. • Evaluate water from other sources (other industry, wastewater, Natural Gas in Coal water, etc.). • Consider innovative water conservation options (non-saline off-sets[14], adaptive management, contingencies). • Evaluate non-water alternatives.
Economic Aspects	Provide screening level economic information, as described in the economics section 3.2.4, for all technical options considered. A detailed (AFE level[15]) review should be conducted for the preferred option, and may be requested by the AENV Director for other options under consideration. Water conservation measures, such as pipeline construction and drilling of new saline water source wells may entail additional costs relative to the lowest cost non-saline water source option.
Net Environmental Effect Aspects	Provide screening level information of the positive and negative environmental aspects, as described in section 3.2.6, for all technical options considered.

12 Figure 12 (Appendix E) demonstrates that approximately 20 per cent of all licensed ER projects would be classified as Tier 2 (or Tier 3) projects, based on project scale. These larger scale projects (Tier 2 criteria) accounted for over 80 per cent of non-saline water volumes injected in 2001.

13 All projects diverting more than 1,000 m^3/d for sustained periods (1 year or more) should use Tier 2 criteria.

14 Water conservation offsets are discussed in Section 3.2.7.

15 An "Authorization for Expenditure" (AFE) economic review is a rigorous evaluation of all aspects of a project through the project life, using accounting standards and methods accepted in the oil and gas industry for investment decisions.

Goal:	Conservation and wise use of water
General Requirements	A description of the ways the proposed project is maximizing water recycling.
Project Scale[1]	Typically an allocation should be less than 450 m³/d.
Typical Projects	• Smaller-scale ER projects in the "Green Area" of Alberta. • Minimal water shortage, cumulative effects or development pressure issues. • Projects in "not regionally water-short" areas based on the interim "water-short areas" map, unless a site-specific evaluation indicates a Tier 2 classification is appropriate.
Technical Aspects – Evaluation of technical alternatives to non-saline water use	Provide information on: Saline sources (see 3.2.3 for further details): • Rigorous evaluation and testing of saline sources within a minimum 3 km radius. • Review well logs and conduct flow tests as appropriate. • Review availability of produced water (including sources from other area operators). • Water recycling is the expected industry practice/norm in all cases. • Seek saline produced water for all or partial needs. • Document alternatives that were considered.
Economic Aspects	Provide screening level economic information, as described in the economics section (3.2.4), for all technical options considered. Water conservation measures, such as pipeline construction and drilling of new saline water source wells may entail additional costs relative to the lowest cost non-saline water source option.
Net Environmental Effect Aspects	Provide screening level information of the positive and negative environmental aspects, as described in section 3.2.6, for all technical options considered.

Where special circumstances indicate that impacts may be significant, the AENV Director responsible for the review of the project may decide a Tier 2 classification is appropriate.

[1] Figure 17 (Appendix I) shows the range of water requirements for typical ER applications and assumed to use Tier 1 criteria.

TIER 2

Goal	Reduced non-saline water use for ER, increased availability of non-saline water to enable economic growth, and protection of the aquatic environment
General Requirements	A description of the ways this proposed project is maximizing water recycling
Project Scale[12]	The use of Tier 2 criteria is typically appropriate for projects using more than 450 m³/d. Larger isolated projects may be considered Tier 1 at the discretion of the Director in some circumstances (i.e. abundant natural runoff, minimal development pressure, undeveloped area, "minor" environmental risks).
Typical Projects	• Large ER and in-situ projects, and all projects in developed areas. • Potential water shortage, cumulative effects or development pressure issues. • All projects in "potentially water-short" areas based on the interim "water-short areas" map. • Direct competing water users.
Technical Aspects – Evaluation of technical alternatives to non-saline water use	As in Tier 1 as well as: • Increased search to minimum 10 km radius for saline water. • Evaluate water from other sources (other industry, wastewater, Natural Gas in Coal water, etc.). • Consider innovative water conservation / options (non-saline off-sets[13], adaptive management, contingencies). • Evaluate non-water alternatives.
Economic Aspects	Provide screening level economic information, as described in the economics section 5.2.4, for all technical options considered. A detailed (AFE level[14]) review should be conducted for the preferred option, and may be requested by the AENV Director for other options under consideration. Water conservation measures, such as pipeline construction and drilling of new saline water source wells may entail additional costs relative to the lowest cost non-saline water source option.
Net Environmental Effect Aspects	Provide screening level information of the positive and negative environmental aspects, as described in section 5.2.6, for all technical options considered.

12 Figure 12: Approvals Communications that specifically require Tier 2 criteria for all proposed ER projects, would be considered as Tier 2 or Tier 1 projects based on project scale. These would typically be Tier 2 criteria recommended for over 450 m³/d of non-saline water withdrawal, or 3,000 bbl/d.

13 All projects diverting more than 1,000 m³/d for oil sands purposes in Tier 1 areas or more than 450 m³/d in Tier 2 areas.

14 Water conservation efforts are discussed in Section 5.2.7.

15 An "Authorization for Expenditure" (AFE) is a document required at the commencement of all major capital projects throughout the petroleum industry. It requires a detailed cost estimate and a standardized method of approval for the oil and gas industry for investment decisions.

Environmental Impact Assessments (EIAs)

Commercial scale thermal ER projects require a formal environmental impact assessment (EIA) and a "public interest" decision by the EUB.

Typically, thermal ER projects that require an EIA fall within the Tier 2 classification used in this Guideline, however the evaluation requirements set out in this document are not directly applicable to projects that conduct an EIA.

EIA evaluation requirements are set individually in a Terms of Reference specific to each project and site. An EIA Terms of Reference has priority over the evaluation criteria in this document, when an assessment of water supply issues is included in the EIA Terms of Reference.

Further information on EIA procedures is available online at www.gov.ab.ca/env/protenf/assessment/index.html.

Explanatory Notes – Tier 2

Large-scale Tier 2 projects may have impacts on the aquatic environment such as drawdown in aquifer water levels over a large area, decreases in stream flow during low flow seasons, or other local or cumulative effects. Smaller scale projects may have local impacts on the aquatic environment and/or cumulative impacts that need to be considered. These impacts need to be weighed against the economic costs of other ER options.

In some circumstances, the potential environmental impacts of alternatives may also be significant (e.g. air emissions, landfill of water treatment waste). These environmental risks need to be considered against the benefits of the proposed water conservation measures in an "environmental net effects" review. Environmental net effects are discussed in Section 3.2.6.

In "potentially water-short" areas of the interim "water-short areas" map (Figure 6), discretion should be used as to whether the project is classified as Tier 2 or Tier 3. Where special circumstances indicate that impacts may be significant, the AENV Director responsible for the review of the project may decide a Tier 3 classification is appropriate.

All projects in these "potentially-water-short" areas should consider ongoing action to reduce non-saline water use over time if there is any feasible alternative to non-saline water use.

TIER 3

General Requirements	A description of the ways this proposed project is maximizing water recycling. Ongoing efforts to minimize impacts on the aquatic environment and other water users. Ongoing efforts to replace non-saline water use with alternatives.
Project Scale	Existing or potential water shortages and associated environmental impact are the prime criteria for a Tier 3 classification. Project scale is a secondary consideration, but may determine whether an allocation can be made (depending on water availability, cumulative effects, etc.). Project scale may affect the risk-based Tier selection process in "potentially-water-short" areas. Larger projects may have major environmental risks (Tier 3) compared to moderate risks (Tier 2) from a smaller project at the same location. In some circumstances, project scale may limit economically feasible options that would replace non-saline water. Where project scale is a limiting factor, consideration should be given to the societal benefits of water conservation versus the economic hardships of stranding oil resources[16].
Typical Projects	ER projects in areas with existing or historical water deficiency, and existing or probable allocation restrictions. All projects in "water-short" areas based on the interim "water-short areas" map.
Technical Aspects – Evaluation of technical alternatives to non-saline water use	As in Tier 1 and 2, and in addition: • Increased search to a minimum 15 km radius. • Rigorous evaluation and testing of saline sources. • Extensive and on-going search for new alternative water sources. • Investigation of non-water alternatives. • Consideration of innovative water conservation options (non-saline off-sets, contingencies). • Evaluation of complex infrastructure and operational requirements (conjunctive use capability[17]). • Consideration of operational adaptive management and environmental stewardship plans (anticipate temporal variations in water availability).

16 Stranded oil resources are reserves that cannot be produced by application of existing ER technology due to economic, environmental or other factors. Production would be deferred until economic constraints decrease or new technologies are feasible.

17 Conjunctive use implies that a single (or combination) of sources may be used during most of a project's life but a separate source may provide alternate water supplies under some circumstances (project start-up, drought, etc.).

Goal	Reduction with the intent to replace all non-saline water use with other methods (where the change has an environmental benefit)
General Requirements	A description of the ways this proposed project is maximizing water recycling. Ongoing efforts to minimize impacts on the aquatic environment and other water users. Ongoing efforts to replace non-saline water use with alternatives.
Project Scale	Existing or potential water shortages and associated environmental impact are the prime criteria for a Tier 3 classification. Project scale is a secondary consideration, but may determine whether an allocation can be made (depending on water availability, cumulative effects, etc.). Project scale may affect the risk-based Tier selection process in "potentially-water-short" areas. Larger projects may have major environmental risks (Tier 3) compared to moderate risks (Tier 2) from a smaller project at the same location. In some circumstances, project scale may limit economically feasible options that would replace non-saline water. Where project scale is a limiting factor, consideration should be given to the societal benefits of water conservation versus the economic hardships of stranding oil resources.
Typical Projects	ER projects in areas with existing or historical water deficiency, and existing or probable allocation restrictions. All projects in "water-short" areas based on the interim "water-short areas" map.
Technical Aspects Evaluation of technical alternatives to non-saline water use	As in Tier 1 and 2, and in addition: • Increased search to a minimum 15 km radius. • Rigorous evaluation and testing of saline sources. • Extensive and on-going search for new alternative water sources. • Investigation of non-water alternatives. • Consideration of innovative water conservation options (non-saline off-sets, contingencies). • Evaluation of complex infrastructure and operational requirements (conjunctive use capability). • Consideration of operational adaptive management and environmental stewardship plans (anticipate temporal variations in water availability).

TIER 3 – CONTINUED

Economic Aspects	Detailed economic review of all options (AFE level) as described in the economics section (3.2.4). Water conservation measures include long-term actions to replace non-saline water supplies. Cost estimates of ongoing water conservation efforts and alternative supply development should be included in the evaluation.
Net Environmental Effect Aspects	Full review and comparison of environmental benefits and impacts of the options. Use topics in the guidelines on net environmental effects for guidance (Section 3.2.6).

Explanatory Notes – Tier 3

Large-scale Tier 3 projects may have impacts on the aquatic environment such as drawdown in aquifer water levels over a large area, decreases in stream flow at low flow seasons, or other local or cumulative effects. Smaller scale projects may also have local impacts on the aquatic environment and cumulative impacts that need to be considered.

All Tier 3 projects have the potential to exacerbate existing and potential stresses on the aquatic environment at a local or basin scale. Consideration must be given to impacts on the aquatic environment during seasonal reductions in precipitation and runoff (environmental flow requirements).

In some circumstances, the potential environmental impacts of alternatives may also be significant (e.g. pipeline spills of saline water, landfill of water treatment wastes). These environmental risks need to be considered with the benefits of the proposed water conservation measures in an "environmental net effects" analysis. In most circumstances, it is likely there is an overall net benefit to water conservation measures in Tier 3 areas, however the environmental net effects may vary between options.

All projects in "water-short" areas based on the interim "water-short areas" map should be considered Tier 3 projects unless the a site-specific evaluation indicates that a Tier 2 classification is appropriate. In some circumstances, the AENV Director may decide that a Tier 2 classification is sufficient based on the potential environmental risks of the project (e.g. small scale, minor impacts, locally abundant water availability), and on the information needed to make water management decisions on issuing the licence. Applicants are advised to consult with AENV staff before proceeding with an evaluation based on "Tier 2" criteria in a "water-short" area (Figures 4a, 4b).

"Water-short Areas" in Tier 3

Identifying of water-short areas is essential to the regulatory process for Tier 3 projects. Appendix B provides definitions, criteria for evaluation of water-short areas in Alberta, and an interim map.

Water Management Plans and Approved Water Management Plans that identify water-short areas may vary the criteria for identification of "water-short" and "potentially-water-short" areas within specified basins. Detailed evaluations of water-short areas in water management plans or approved water management plans have priority over the maps provided in Appendix B.

Figures 4a and 4b show detailed maps of the "water-short and "potentially-water-short" areas in Alberta. These maps can be used by applicants as a basis for classification of projects as Tier 2 or Tier 3, in conjunction with other factors discussed in this Section.

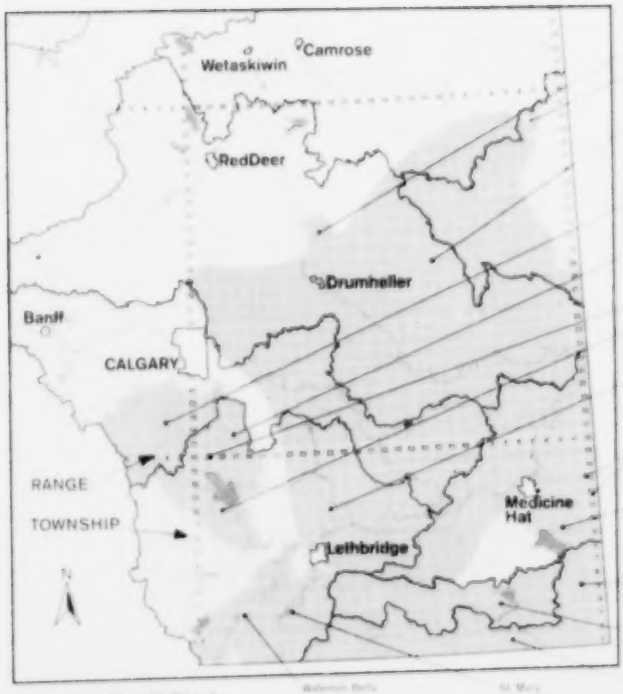
Appendix B describes the basis for identifying water-short areas that is used on the Interim water-short areas maps, and discusses factors that can be considered in establishing water-short areas during water management planning (at the watershed or aquifer scale).

Figure 4a.
Interim Map of Water-Short Areas in Southern Alberta
Watershort Areas Assessment (2006) : Detail for Southern Alberta

Camrose
Wetaskiwin
RedDeer
Banff
CALGARY
RANGE
TOWNSHIP
N
Michichi Creek Basin (west branch)
Hansman Lake (Basin)
Deadfish and Berry Creek Basins
Highwood River Basin
Little Bow River Basin above Twin Valley Reservoir
Mosquito Creek Basin
Milow Creek Basin
Little Bow River Basin below Travers Reservoir
Many Island Lake Basin and Mackay-Boxelder Creek Basin
Bullshead, Ross and Gros Ventre Creeks Basins
Lodge, Battle and Middle Creeks Basins
Pakowki Lake Basin
Milk River Basin
Waterton Belly River Basin
St. Mary River Basin
30 0 30 60 Kilometer
Assessment Criteria
Water-short – considered either "exceptionally dry" or the area / watershed has been closed to most or all new water applications. Basins that are specifically listed have administrative restrictions.
Potentially Water-short – considered either relatively dry or the area / water watershed has a generally high level of allocations compared to natural supply.
Not Regionally Water-short – (water-short areas may be present locally).
Alberta

This map is intended to flag areas where water supply may be of concern. When depicting regional conditions as shown above, the actual local conditions may vary.

Figure 4a



Alberta

Figure 4b.

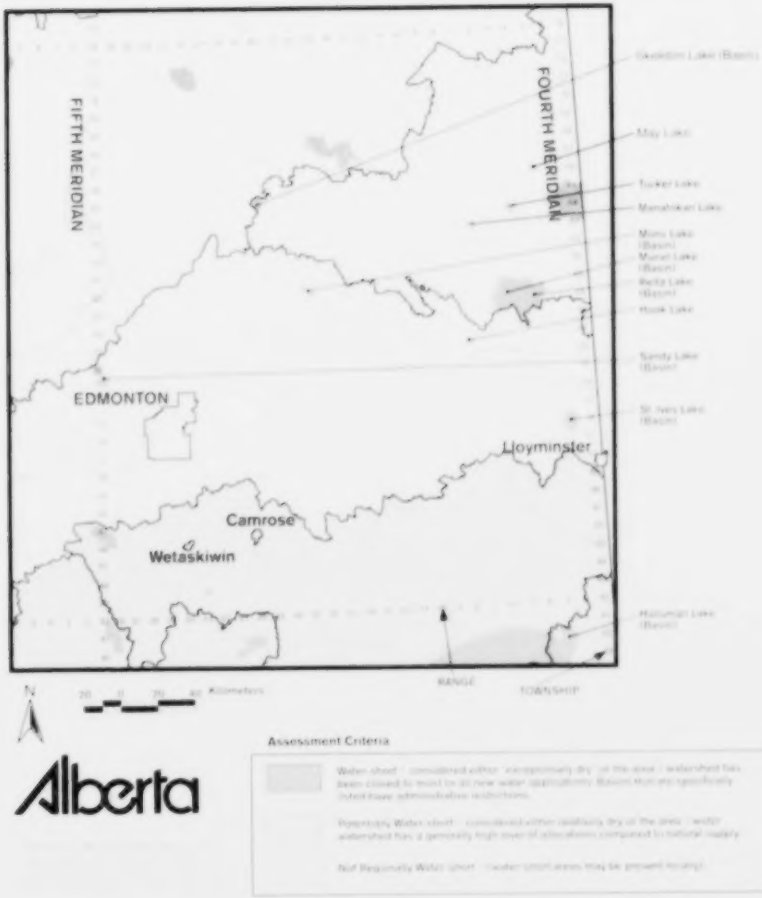
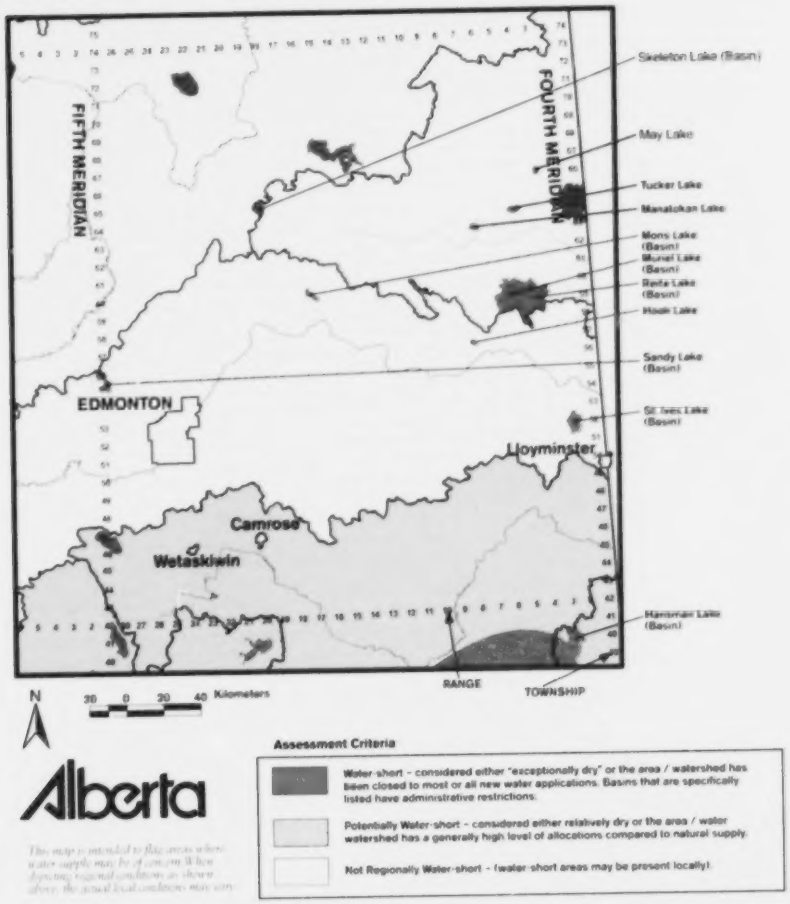

FIFTH MERIDIAN
FOURTH MERIDIAN
EDMONTON
Lloydminster
Camrose
Wetaskiwin
RANGE
TOWNSHIP
Kilometers
Assessment Criteria

Figure 4b.
Interim Map of Water-Short Areas in East-Central Alberta
Watershort Areas Assessment (2006) : Detail for Lakeland-East-Central Alberta


FIFTH MERIDIAN
FOURTH MERIDIAN
Skeleton Lake (Basin)
May Lake
Tucker Lake
Manatokan Lake
Mons Lake (Basin)
Muriel Lake (Basin)
Beta Lake (Basin)
Hoole Lake
Sandy Lake (Basin)
St. Ives Lake (Basin)
EDMONTON
Lloyminster
Camrose
Wetaskiwin
Hamman Lake (Basin)
RANGE
TOWNSHIP
N
30 0 20 40 Kilometers
Alberta
This map is intended to flag areas where water supply may be of concern. While depicting regional conditions as shown above, the actual local conditions may vary.
Assessment Criteria
Water-short - considered either "exceptionally dry" or the area / watershed has been closed to most or all new water applications. Basins that are specifically listed have administrative restrictions.
Potentially Water-short - considered either relatively dry or the area / water watershed has a generally high level of allocations compared to natural supply.
Not Regionally Water-short - (water-short areas may be present locally).

New Projects in Water-Short Areas

New projects within "water-short areas" that propose to use non-saline water must demonstrate that every feasible option has been evaluated and only non-saline water resource use will prevent stranding oil resources. It is a general objective to replace all non-saline water use in water-short areas with other ER fluids.

In some water-short areas, new allocations cannot be issued due to administrative restrictions, and major impacts on aquifers or the aquatic ecosystem may occur in areas with low natural runoff. These (or other) factors may prevent a new licence being issued for oilfield injection in "water-short" areas.

In circumstances where no feasible alternative exists, consideration should be given to delaying ER projects until new technology or alternative water sources are available. This is particularly applicable to projects where major impacts are predicted during the risk assessment process (Section 3.2.1). In some circumstances, it may be feasible to proceed with a new ER scheme using non-saline water on an intermittent-injection basis (i.e. only when above average natural precipitation or seasonal run-off occurs).

In all cases where new oilfield injection projects are proposed for "water-short" areas, environmental risks need to be carefully weighed against economic benefits of the project. The consequences of not proceeding with the project must be considered as one of the options.

Existing Projects in Water-Short Areas

Ongoing efforts, to reduce and eliminate non-saline water use is essential to any ER project. Project plans should also include "environmental stewardship" measures to minimize water use during low flow seasons and drought periods. This might include injection reductions, conjunctive use of low-yield alternative supplies, or other stewardship measures during times when severe water shortages occur due to drought conditions.

Geographical variations in water management criteria may occur as a result of Water Management Plans, Approved Water Management Plans, or the requirements of individual licences in "water-short" areas (Tier 3 projects). Water management plans may establish basin or watershed scale requirements for water use, emphasizing water conservation and initiatives to replace non-saline water with other fluids.

3.2.3 SELECTING ALTERNATIVE WATER SOURCES AND ER METHODS (ALL APPLICATIONS)

The level of alternative water source evaluation required will vary according to the degree of potential impacts on the aquatic environment, non-saline aquifers, other water uses, and the complexity of options evaluated. In "water-short"[18] areas, maximum efforts must be made to evaluate and implement saline water sources or other ER methods, including ongoing efforts to eliminate the use of non-saline water sources.

18 Water short areas occur where natural conditions and/or development pressures are likely to limit the availability of surface water and groundwater for future sustainable development and the protection of the aquatic environment. (See Section 3.2.2)

Evaluating the technical requirements, environmental impacts, socioeconomic factors and economic costs and benefits of various options is a complex task. In many cases, evaluation of potential sources may lead to the use of more than one source, either continuously or conjunctively[19].

The following list provides some of the possible sources that should be considered during evaluation of an enhanced recovery project, approximately in the order of environmental preference. Environmental impacts and other relevant factors need to be evaluated for each project individually.

Possible Water Sources

1. Produced water
2. Saline groundwater
3. Non-water fluids and methods
4. Recycling options
5. Industrial wastewater
6. Municipal Wastewater
7. Potential offset water supplies
8. Water from coalbed methane (Natural Gas in Coal) projects

Pipelines and Shared Water Sources

Existing saline water pipelines in the vicinity of a project may be an effective option for conventional ER water floods in areas with a long history of oil production. Maps of existing pipelines are available from the EUB.

Industry proponents of ER schemes are expected to evaluate potential produced water supplies that are accessible to the project, with an emphasis on using produced water that is disposed of. Proponents are expected to identify and investigate the availability of produced water from all wells that might provide saline water to the new project.

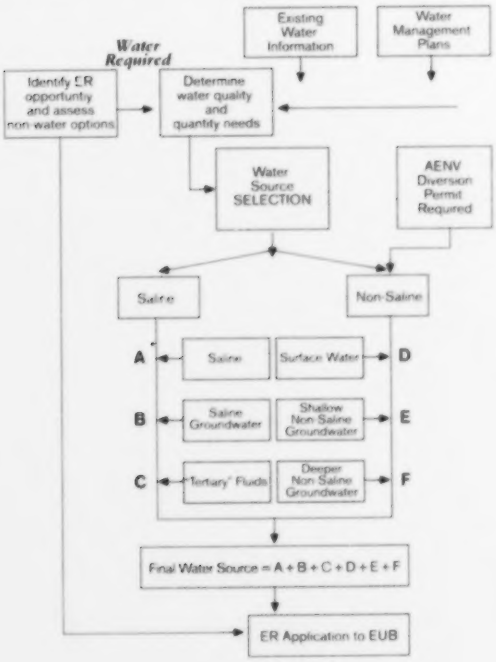
Proponents must investigate the water chemistry of potential saline sources to establish compatibility information, including compatibility of water with existing reservoir fluids (water and hydrocarbons) and the reservoir matrix. Identifying water treatment options and costs is important in evaluating both saline and non-saline water sources.

Industry operators must cooperate in minimizing the use of non-saline water for ER. In many areas of new and ongoing ER development, excess saline water pipeline capacity exists and extensive produced water disposal occurs. Proponents need to negotiate reasonable compensation for the use of existing infrastructure. If reasonable access to excess supplies cannot be agreed between industrial operators, the EUB may be able to assist in facilitating additional discussions.

19 Conjunctive use implies that a single (or combination of) source(s) may be used during most of a project's life, but a separate source may provide alternate water supplies under some circumstances (project start-up, drought etc.).

Figure 5 shows a "decision tree" for optimizing the ER fluid selection process.

Figure 5.
Alternate water sources and ER methods



Procedures for Identifying and Evaluating Saline Aquifers

Saline ground water sources, including produced water from ongoing production and saline water source wells not part of an existing hydrocarbon production operation, are the most feasible alternative to the use of non-saline water in many ER projects in Alberta.

Evaluation of saline aquifers as an alternative to using non-saline water sources includes the following:

- Identification of existing and future water supplies in the vicinity of the project, from existing primary production and from ER schemes that have excess produced water capacity.
- Identification of saline aquifers (down-hole geophysical logs and drill stem tests) in existing production or exploration wells. Mapping of the extent and permeability/porosity of saline zones is essential.
- Evaluation of potential water chemistry and formation compatibility issues. In some circumstances, water treatment options will need to be evaluated (i.e. hardness or silica in water to be used for steam generation in thermal ER).
- Perforation and drill stem tests or pump tests of saline zones in suspended or abandoned wells near the project injection wells, or near saline water pipelines accessible to the project.
- Drilling, completion and pump testing of new wells as saline water source wells.

The *Water Act* exempts the use of saline water from licensing requirements. An application for this use is not required.

NOTE Discharge of saline water to surface is prohibited under EUB and AENV regulations. Pump testing of high capacity wells requires significant on-site water storage. Staged testing is usually needed - with preliminary short-term tests prior to pipeline construction, followed by long-term sustainability pump tests after initiation of the ER scheme.

Alberta Environment's *Groundwater Evaluation Guideline*[20] provides general guidance for evaluation of aquifers.

NOTE the licence application requirements in the *Groundwater Evaluation Guideline* are not applicable to saline aquifers.

The extent of evaluation appropriate to each project increases with the size of the project, project duration, potential environmental and human impacts, and the degree of water shortage or limitations in water supply. The Tiered allocation framework (section 3.2.2) provides guidance regarding appropriate evaluation effort. Discretion is needed in applying the framework recommendations to individual projects. Applicants should consult with EUB and AENV staff during the design of an evaluation program (contact information is provided in Appendix A).

Saline water sources may provide all or a portion of the water needs of an ER scheme, depending on the well yields(s), saline aquifer sustainability and the availability of other alternatives. In some circumstances, conjunctive use of saline groundwater and non-saline water sources may be the best alternative. Combinations of saline and non-saline water supplies may also be the best option during periods when climatic variability reduces the availability of non-saline groundwater or surface water.

Non-water Fluids and Methods

Options for consideration in selecting non-water alternatives include:

- Hydrocarbon solvents
- Carbon dioxide
- Polymer agents to reduce flow in permeable zones
- Air injection (thermal ER projects)
- Other innovative methods to reduce hydrocarbon viscosity or control fluid flow within the reservoir.

Recycling Options

Options for recycling produced water include:

- Water from Existing ER schemes.
- Produced water from other primary production wells in the same field.
- Enhanced water recycling at thermal ER projects (from water treatment and boiler reject streams that would otherwise be disposed through deep well disposal operations).

All projects are expected to maximize the recycling of produced water in order to conserve and prevent wasting of non-saline water supplies. Produced water recycling is also needed to minimize the volumes of water disposed through deep well disposal operations.

20 Groundwater Evaluation Guideline. AENV. 2003 www.gov.ab.ca/env/water/Legislation/Guidelines/GroundwaterEvaluation.pdf

The EUB has established recycling requirements for thermal ER projects (IL-89-5) and regulates the disposal of produced water through Guide 51. Further information is provided in Appendix C for the EUB regulatory documents (C.3 EUB Guidelines).

Industrial and Municipal Wastewater Sources

In some circumstances, environmental improvements can be achieved by suitable treatment and use of industrial and municipal effluent. It is possible that a lesser degree of treatment is needed to make industrial and municipal effluent suitable for injection in ER projects than is needed to treat these effluents for return to surface water bodies.

Offset Water Sources

For some projects, it may be feasible to offset the environmental impacts of a proposed water diversion by improving water storage capabilities or providing alternatives to the existing water use at another project in the area. This is further discussed in section 3.3.7.

Water From Coalbed Methane (Natural Gas in Coal) Projects

Recent increases in the development of shallow gas resources in coal beds may provide new potential sources of saline or marginally non-saline water. Consideration needs to be given to water quality, sustainable yields, and aquifer and aquatic ecosystem impacts of coalbed methane water sources on a case-by-case basis.

The regulatory process for diversion of non-saline water for coalbed methane production has not been finalized. Applicants considering this option should consult with AENV staff during the development of their alternative sources evaluation program.

3.2.4 ECONOMIC ASPECTS

All new applications must include information on economic aspects of the alternative water source options. As indicated in the Tier Evaluation Criteria (section 3.2.2), either a Screening Level Review or an AFE Level Review will be required.

Screening Level Review

The screening level analysis must enable a reasonable comparison of economic costs and water conservation benefits for all of the options considered.

A screening level review must be provided for each technical alternative considered (see section 3.2.2). The review must include:

- Evaluation and exploration costs
- The capital cost of construction
- The annual operating and maintenance cost (e.g. water treatment, recycling, pipeline access and transport, power costs, etc.).

The review must also assess the overall water and hydrocarbon budget ("resource productivity") of the project, including assessment of productivity variations between technical alternatives (if significantly different). The productivity assessment must include:

- The overall water volume needed throughout the project life and the volumes of non-saline water needed. Volumes of non-water fluids (CO_2, etc.) should also be assessed.
- The overall hydrocarbon reserves (proven and probable) and total estimated production from the project.
- An estimate of the project duration and schedule of water injection.

- An estimate of volumes of hydrocarbon produced versus volumes of non-saline water used through the project life (i.e. resource productivity trends).

For proposed projects where a screening level review is selected, the applicant will summarize the results of the technical alternatives, economic information and environmental information in a table similar to the example below.

Technical Alternative	Economic Information		Environmental Information
	Capital Costs	Annual Operating Expense	
Alternative 1	$XXXX	$YYYYYY	ZZZZZ
Alternative 2	$XXXX	$YYYYYY	ZZZZZ
Alternative 3	$XXXX	$YYYYYY	ZZZZZ

The applicant will conduct a rigorous analysis of the project to determine the economic impact or opportunity each water alternative considered will have on the overall project. The usual AFE standards used in the oil and gas industry are expected.

This Guideline does not mandate an arbitrary methodology. However it does require a meaningful economic analysis that supports an effective decision by the AENV Director. It is recommended that the applicant consult with AENV EUB staff regarding the economic analysis approach prior to proceeding with a detailed review.

The following information will be provided by the applicant for the economic analysis of each water alternative:

1) An evaluation of the net present value (NPV). This will be a before-tax analysis.

2) The commodity price forecasts used in evaluations of ER projects that require non-saline water must be the most recently published by Chemery Dobson Resource

- An estimate of volumes of hydrocarbon produced versus volumes of non-saline water used through the project life (i.e. resource productivity trends).

Qualitative Evaluation of Alternatives

For proposed projects where a screening level review is selected, the applicant will summarize the results of the technical alternatives, economic information and environmental information in a table similar to the example below.

Technical Alternative	Economic Information		Environmental Information
	Capital Costs	Annual Operating Expense	
Alternative 1	**$XXXX**	**$YYYYYY**	ZZZZZ
Alternative 2	**$XXXX**	**$YYYYYY**	ZZZZZ
Alternative 3	**$XXXX**	**$YYYYYY**	ZZZZZ

Authorization for Expenditure (AFE) Level Review

The applicant will conduct a rigorous analysis of the project to determine the economic impact or opportunity each water alternative considered will have on the overall project. The usual AFE standards used in the oil and gas industry are expected.

This Guideline does not mandate an arbitrary methodology. However it does require a meaningful economic analysis that supports an effective decision by the AENV Director. It is recommended that the applicant consult with AENV/EUB staff regarding the economic analysis approach prior to proceeding with a detailed review.

The following information will be provided by the applicant for the economic analysis of each water alternative:

1) An evaluation of the net present value (NPV). This will be a before-tax analysis.

2) The commodity price forecasts used in evaluations of ER projects that require non-saline water must be the most recently published by Chenery Dobson Resource

Management[21] (or an equivalent data source as agreed by AENV and EUB). The forecast used for oil/bitumen and natural gas liquids will be the average nominal large firms' "consulting price" FOB Edmonton in C$/BBL.

3) Information to support calculation of remaining reserves and to establish the production forecast.

4) A detailed breakdown of capital and operating costs (e.g. power costs, water treatment costs) for each of the alternatives.

5) Information on the long-term inflation rate. This will be based on the Consumer Price Index forecast, which is available in Dobson's Survey.

6) Information on the discount rate. This will be equal to the prime lending rate of the Alberta Treasury Branch on loans payable in Canadian dollars plus three per cent based on the preceding month that the evaluation is conducted. The discount rate will be reviewed periodically by the EUB and will be revised if the capital costs for the oil and gas industry change significantly.

7) Only incremental revenue, minus net royalties, from oil and gas that would otherwise not be recovered by primary production will be included in the economic evaluation.

The applicant should highlight the following aspects to support project planning and the water diversion licence application:

1) Economic evaluation to compare the NPV of the ER scheme (over the project life) of each feasible alternative.

2) Detailed analysis of the costs for each feasible alternative, including the cost of environmental stewardship, contingency measures and conservation methods that would be implemented during the project life. This will assist in selecting the best combination of water sources and ER methods for the project.

Should an operator determine that non-saline water use is the preferred option, a comprehensive economic report must be submitted. The report must incorporate the preceding information and provide sufficient detail to allow the results to be verified.

Economic costs must be balanced against environmental impacts and the benefits of water conservation efforts. It is a general objective to achieve maximum water conservation without stranding oil and gas resources in Alberta. However, some projects classified as "Tier 3" may be deferred (oil resources "stranded") as a result of water supply limitations, major environmental risks or project economic constraints. It is anticipated that future technology (and oil price fluctuations) may make some ER projects economically feasible that are not currently competitive with other investment opportunities.

Licence Renewals and Economic Evaluation

All renewals must include applicable economic evaluation information, as new applications would. Licence renewal applications should refer to any initial applications made under this Guideline and provide an assessment of alternative water conservation options for the next term of the licence.

21 The forecasts are available in Dobson's publication: *Survey of Hydrocarbon Price Forecasts Utilized by Canadian Petroleum Consultants and Canadian Banks*, which is updated semi-annually and available at a nominal cost per publication. The publication is also available in the EUB Library.

Applications without Economic Evaluation

There are a limited number of circumstances in which an economic evaluation will not help make water management decisions. These include short term "pilot type projects" that are used by industry to evaluate the economic and technical limitations of a potential ER project, and projects in the final year(s) of operation where it would not be reasonable to make new capital investments.

NOTE: Although economic evaluation information is not usually required for these "exempt" projects, it is expected the operator will still use saline sources, if available.

It also is the general guidance of this document that projects that have already made significant water conservation investments, and achieved results that support *Water for Life* objectives, may be granted relief from detailed economic evaluations during licence renewals at the discretion of the Director.

These exemptions are discussed in Part B (Section 2.1) of this document.

NOTE: The AENV Director responsible for issuing *Water Act* licences may require additional information for any licence application (WA s. 51).

3.2.5 CUMULATIVE EFFECTS

An evaluation of the impacts of surface water or groundwater evaluation on the local environment and other water users is essential to any application to use non-saline water resources.

The evaluation must determine the cumulative effects on the aquatic environment and existing water users that will result from all diversions within the geographical area where the applicant's water use will have an impact.

In areas where many new ER projects are under development consideration must be given to the long-term consequences on the watershed, aquifer or basin. This assessment includes (but is not limited to):

- a quantitative evaluation of cumulative effects for proposed projects (if information is publicly available) and present and future water use at existing projects.
- an evaluation of future water supply availability in comparison to allocation trends in the watershed, aquifer or basin.

The extent of time and geographical area of the cumulative effects assessment depends on the scale of the project and the specific interactions of that project and other projects in the area. It is recommended that applicants consult with AENV staff regarding the evaluation of cumulative effects for individual applications.

3.2.6 ENVIRONMENTAL NET EFFECTS EVALUATION

The comparison of overall environmental risks and benefits of alternative water sources is the basis for an environmental net effects analysis.

In some cases, the use of an alternative technology or alternative water source may result in more environmental impacts than the use of non-saline water. This circumstance may arise in any project or geographic area, but is most likely to occur in Tier 1 cases.

By switching to saline water use for the intended project, it is expected there will be additional energy requirements for obtaining the saline water, resulting in higher project emissions. In addition, there will likely be increased land disturbance for saline pipelines, additional waste products and associated environmental footprint to safely dispose of these products.

In the evaluation of net environmental effects, it is necessary to consider these negative aspects and weigh them against the positive benefits of reduced non-saline water use. It may be that in a Tier 3 case, the best choice would be to proceed with developing saline water supplies, with acknowledgement of the other negative impacts. In a Tier 1 case, it may be best to proceed using non-saline water.

For example, in an area of the province where non-saline water is readily available (Tier 1) and where the aquatic ecosystem, supplies for drinking water, and supplies for a sustainable economy are not stressed, the environmental impacts of using non-saline water are likely small. In contrast, the same water use in a water-short area (Tier 5) may cause additional cumulative impacts to aquatic organisms and additional water allocations may not be available because licensed water use limits have been reached.

"Screening" Level Review

In many cases, a simple comparison of the positive and negative environmental aspects for each technical alternative considered will provide enough environmental information to support a water allocation decision. A screening level review will provide, for each technical alternative considered, a brief response to each question in the "Net Effects Considerations" below. The applicant may address additional topics as circumstances warrant or where requested to do so by the Director.

"Environmental Evaluation" Level Review

An environmental evaluation level review requires a thorough review of the environmental effects of the alternatives when considering complex circumstances surrounding the project.

A review will provide, for each technical alternative considered, a detailed response to each of the questions asked as example topics in the listing below. The project applicant and the AENV Director may address additional topics as circumstances warrant.

A formal Environmental Impact Assessment, mandated by the *Environmental Protection and Enhancement Act*, requires a separate Terms of Reference for each assessment designed to address the environmental issues of that project, including water management issues, and is not covered by this Guideline. Further information is available from the AENV website[22], or by contacting AENV regional offices.

Net Effects Considerations

The following questions are examples of topics to consider during an environmental net effects analysis:

- Will the use of alternative technology result in the generation of a larger environmental footprint?
- Will the use of alternative technology result in additional energy expenditure creating:
  - Additional greenhouse gas emissions?
  - A decline in overall project efficiency and productivity?

22 A document describing the environmental assessment process is available online: www.gov.ab.ca/env/protect/assessment/pubs/EAProcessGuide.pdf

- Will there be additional waste disposal requiring additional landfill capacity?
- Will there be additional liquid waste requiring additional disposal well capacity?
- Will there be additional negative gas emissions (NOx, SOx, H2S)?
- Will the project require additional land clearing:
  - Of agricultural, wetlands, forested areas?
- Will there be additional habitat disturbance?
- Are there risks from using an alternative water supply?
- Is the alternative water hazardous (e.g. H2S, corrosive)?
- Will the alternative water supply change a sweet oil supply into a sour supply?

While these additional project impacts may be difficult to compare directly to environmental benefits from using less non-saline water, it is necessary to consider both the advantages and potential disadvantages of alternatives.

3.2.7 WATER SUPPLY OFFSETS

Water supply offsets are innovative water supply improvement or replacement options at other projects that can mitigate the impacts of oilfield injection use of non-saline water. In some circumstances, providing alternatives to the use of non-saline water may be impractical at one site within a watershed, but readily available at another location.

The offsets should be located as close as possible to the ER project and should not have negative environmental impacts on water users, water supply, the aquatic environment, or non-saline aquifers at the project site. Water conservation measures are not transferable as offsets between ER projects (maximum feasible water conservation is expected at all projects).

When considering cumulative effects, reduction in consumptive use of another existing licence may be considered as a water conservation benefit provided by a new or renewed ER project. The applicant must demonstrate an overall reduction in water consumption in the watershed through financial or other initiatives that have a real benefit of water conservation. The proposed offsets must not lead to water supply hardships in another watershed or aquifer, or adversely affect the water diversion priorities of existing water users.

Innovative offset opportunities that return useable water to a watershed will be considered in the water allocation decision. Offset opportunities that increase basin storage or replace uses of high-quality water supplies with saline or effluent sources may increase the available water supply for all users. Offsets may mitigate cumulative effects on the aquatic environment in areas where overall water availability is stressed ("water-short" and "potentially-water-short" areas).

3.2.8 WATER-SHORT AREAS

Water-short areas identify parts of Alberta where water availability is crucial to any evaluation of the use of non-saline water for oilfield injection projects.

Appendix B describes the basis for identifying "water-short and "potentially-water-short" areas in Alberta and provides an interim map of water-short areas in the province based on analysis of runoff and allocation in sub-basins. The basis for mapping "water-short" and "potentially-water-short" areas is shown on Figure 11 of Appendix B.

Additional analysis is needed at the watershed scale to identify local water-short and potentially-water-short areas. This level of analysis is a component of Watershed Management Planning and will be addressed in future phases of water management plans for Alberta watersheds.

Integrating evaluation of groundwater and surface water resources at the watershed scale has particular challenges. In some circumstances, a deep non-saline aquifer may provide a water source that has reduced impact on the water resources and aquatic ecosystem relative to use of surface water. In other circumstances, the use of groundwater resources may reduce the basin storage component where a watershed already has a low surface storage capacity.

Groundwater resource evaluations are required on a case-by-case basis until a more complete understanding of groundwater and surface water interactions is available. The interim mapping of water-short and potentially-water-short areas combines water allocations for groundwater and surface water.

The interim water-short areas map shown in Figure 6 is a basis for identifying Tier 3 areas. Areas identified as "water-short" should be evaluated using Tier 3 criteria unless a detailed local or watershed scale analysis indicates that a less rigorous classification (Tier 1 or Tier 2) is available for that area (at the discretion of the Director).

Areas identified as "potentially water-short" on the interim map may be considered as Tier 2 projects in most circumstances, with the Director's discretion as to whether individual projects should be classified as Tier 3, based on the assessment of environmental risk and future water demand in the area.

Figure 6.

Alberta

Assessment Criteria

Water-short – considered either "exceptionally dry" or the area / watershed has been closed to most or all new water applications.

Potentially Water-short – considered either relatively dry or the area / watershed has a generally high level of allocations compared to natural supply.

Not Regionally Water-short – (water-short areas may be present locally).

Figure 6.
Overview of water-short areas.
Watershort Areas Assessment (2006)

Alberta

This map is intended to flag areas where water supply may be of concern. When designing regional schemes as shown above, the actual local conditions may vary.

Assessment Criteria

- Water-short – considered either "exceptionally dry" or the area / watershed has been closed to most or all new water applications.
- Potentially Water-short – considered either relatively dry or the area / watershed has a generally high level of allocations compared to natural supply.
- Not Regionally Water-short – (water-short areas may be present locally).

3.3 QUALIFICATIONS OF PERSONNEL

Applications for use of non-saline water resources must meet the following requirements:

- Evaluation of saline water sources and produced water sources will be carried out by professional geologists or reservoir engineers with experience in the area, aquifers and formations being investigated. Reports must be signed and stamped (APEGGA).
- Experienced and qualified hydrologists will carry out evaluation of potential surface water sources. Reports must be signed and stamped (APEGGA).
- Evaluation of potential non-saline groundwater sources will be carried out by experienced and qualified hydrogeologists in accordance with the Groundwater Evaluation Guideline (2006). Reports must be signed and stamped (APEGGA).
- Comparison of economic costs will be carried out according to generally accepted accounting principles, by qualified and experienced personnel. Cost estimates will be detailed, defensible and based on recent actual costs for similar work. Economic evaluations (including cost parameters) should be auditable. Economic evaluation reports must be signed and stamped by a member of APEGGA who is familiar with AFE economic analysis, or by an accredited accounting professional.

part – monitoring and reporting:

4.0 IMPROVED REPORTING AND MONITORING INFORMATION

Reporting of information by project operators (in compliance with licence conditions) - including water use, and monitoring data will be made readily available to members of the public. AENV will provide "state of the environment" information to the public, including information regarding oilfield injection uses of water.

- Technical reports (licence application supporting documents) and water use data for both non-saline and saline water will be available on the AENV Approvals Viewer[23] or from AENV regional offices.
- Non-saline and saline water use information that is reported to AENV will be publicly available on a watershed/basin basis with "state of the environment reporting" by AENV. The AENV web-site provides provincial-scale information on oilfield injection water use trends in an "environmental pressure" *State of The Environment Report*[24].
- Digital reporting of water use and environmental monitoring will be initiated to improve accessibility of oilfield injection data.

Monitoring and Reporting – Licence Conditions

Monitoring and reporting requirements are established for each *Water Act* licence issued, as a condition of the licence.

The monitoring and reporting conditions may be updated at the renewal of a term licence, and also may be amended within the licence term, at the discretion of the Director, in accordance with Section 54(1) of the *Water Act*.

4.1 PERFORMANCE MEASURES AND PROGRAM EVALUATION DATA

Performance measures are quantitative "tools" or "criteria" that assess the achievement of specific outcomes. A summary of performance measures to assess the outcomes for oilfield injection is provided in the following table.

These performance measures are a component of a comprehensive review of oilfield injection policy and conservation practices to be conducted in 2007-2008.

23 AENV Approvals viewer: www.gov.ab.ca/env/water/ApprovalViewer.html
24 www.gov.ab.ca/env/soe/water_indicators/29_oilfield_inj.html

PERFORMANCE MEASURES TO ASSESS OILFIELD INJECTION OUTCOMES:

SREM[25] Outcome	Performance Measure
Reduction/elimination of non-saline water use.	Thermal and conventional ER separately, by basin 1. Per cent allocation reduction between 2005 and 2007. 2. Per cent non-saline water use reduction (surface water, groundwater) between 2005 and 2007. 3. Per cent increase in use of saline groundwater between 2005 and 2007. 4. Per cent increase in use of alternate (non-water) ER methods (per cent increase in ER oil production using alternate methods).
Improved productivity and efficiency of water use.	Thermal and conventional ER separately 1. Resource productivity (ER cubic metres of oil/bitumen per cubic metre of non saline water). A trend line is desirable.
Conservation and protection of non-saline aquifers and aquatic ecosystems.	1. Reduction in water use in water-short and potentially water-short areas (oilfield injection, other consumptive uses). 2. Stakeholder Assessment Process. 3. Qualitative assessment of progress in stewardship, data, knowledge management, overall results. 4. Reductions in allocation and water use for permanent licences.
Improved Partnership and Research initiatives.	1. Qualitative documentation (and evaluation) of partnership and research initiatives. 2. Stakeholder assessment process. 3. Qualitative evaluation by WPACs and AWC.

25 SREM: Sustainable Resource and Environmental Management as described on page 6

Figures 7 and 8 show trends in the use of saline and non-saline groundwater for oilfield injection over time. These trends help measure progress in reduction/elimination of non-saline water use for oilfield injection. Changes in the volumes of saline and non-saline water used between 2004 and 2007 are a performance measure for evaluating the success of the *Water Conservation and Allocation Policy for Oilfield Injection*.

Figure 7.

Total fresh, saline groundwater and surface water use for conventional enhanced oil recovery in Alberta, 1977-2004

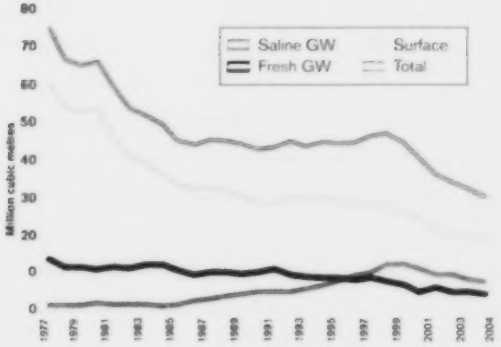
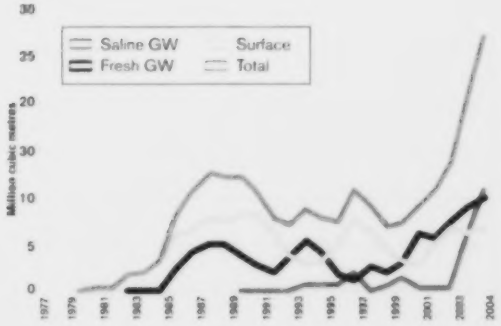


Figure 8.

Total fresh, saline groundwater and surface water use for thermal enhanced recovery in Alberta, 1977-2004



4.2 STATE OF ENVIRONMENT INDICATOR – WATER USED FOR OILFIELD INJECTION PURPOSES

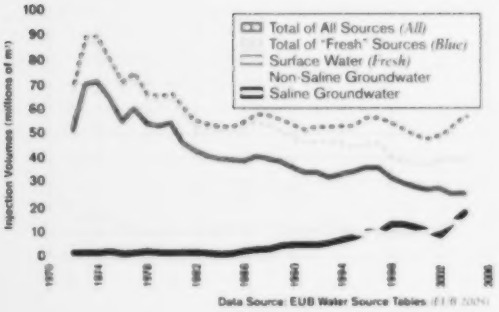
Another measure of achieving outcomes proposed for management of oilfield injection is the total water used for oilfield injection. This indicator is prepared by AENV annually and published on-line[26].

The indicator provides a trend of water used for conventional enhanced recovery and thermal enhanced recovery as a measure of environmental pressure on water resources.

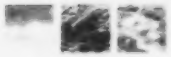
Figure 9 shows the trend of the State of the Environment indicator to 2004.

Figure 9.

Source water use over time



26 www.gov.ab.ca/env/soe/water_indicators/29_oilfield_inj.html



part – adaptation & management *System Review*

5.0 WATER EFFICIENCY AND PRODUCTIVITY OBJECTIVES

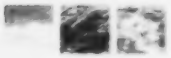
The "water efficiency and productivity" objectives in *Water for Life: Alberta's Strategy for Sustainability* provide context for establishing targets for underground injection. The Alberta Water Council will provide an approach to water efficiency and productivity planning to be used by Watershed planning and Advisory Councils (WPACs) in watershed planning.

In consultation with stakeholders, WPACs will evaluate and recommend Sectoral Water Conservation Targets, which will be incorporated into Water Management plans.

It is essential that government agencies and industry collect data in the 2005-2007 period to assist WPACs in evaluating water conservation, productivity and efficiency in oilfield injection projects. Since productivity and efficiency targets can result in an increase in water use in areas where there are many new projects, industry must work with the WPACs to establish meaningful conservation targets for the future.

5.1 2007-2008 PROGRAM REVIEW

The effectiveness of the water conservation measures implemented during 2005-2007 will be assessed during a 2007-2008 program review conducted by AENV. The Policy, Guideline, regulatory delivery, and the overall environmental management system for oilfield injection may change following the review.



part – complementary actions

6.0 WATER CONSERVATION

The water conservation measures outlined in this Guideline are part of a broader effort to conserve water resources in Alberta.

New efforts to develop improved enhanced recovery methods and practices in the oil industry will form an important component of this overall initiative. These efforts include industry research and development initiatives, joint industry-government research programs, and government initiatives to develop effective environmental management systems, including the use of flexible regulatory tools and incentives, where possible.

Industry-government cooperation to achieve the water conservation objectives in *Water for Life: Alberta's Strategy for Sustainability* is essential. This includes participation in the work of the Alberta Water Council, Water Management Plan development, Watershed Planning Advisory Councils, local community-industry cooperative associations, regional environmental initiatives, and government-industry partnerships to address specific issues.

6.1 RESEARCH INITIATIVES

Industry participants who are pursuing innovative enhanced recovery opportunities or research projects can contact AENV or the Alberta Energy Research Institute. Other programs lead by industry groups such as CAPP, PTAC and CONRAD are actively engaged in the development of improved ER methods in Alberta.

6.2 ALBERTA WATER COUNCIL

The Alberta Water Council has an important role in recommending changes to water management in Alberta, under the *Water for Life* strategy. The Council will evaluate the value of water in Alberta's economy, review the use of economic instruments in water management, and provide advice to the Government of Alberta on other vital issues relevant to the management and regulation of water resources in the province.

Additional information on the activities of the Alberta Water Council is available on-line at: www.waterforlife.gov.ab.ca

appendix

Appendix A – Contacts

Appendix B – Water-short Areas

Appendix C – Information Sources

Appendix D – Sustainable Resource Environmental Management System For Oilfield Injection

Appendix E – Evaluation of Project Scale

Appendix F – Glossary

APPENDIX A – CONTACTS

ENVIRONMENTAL APPEALS BOARD

Environmental Appeals Board
306 Peace Hills Trust Tower
10011 – 109 Street
Edmonton, Alberta
Canada T5J 3S8

Tel: 780.427.6207
Fax: 780.427.4693
Web: www.gov.ab.ca/eab
E-Mail: gilbert.vannes@gov.ab.ca

ALBERTA ENERGY AND UTILITIES BOARD
EUB CONTACTS
Main Switchboard
Calgary Office
640 – 5 Avenue SW
Calgary, Alberta
Canada T2P 3G4

Tel: 403.297.8311

APPLICATIONS HELP LINES
Facilities Applications (Guide 56)
Tel: 403.297.4369
E-Mail: guide56.help@gov.ab.ca

Resources Applications (Guide 65)
Tel: 403.297.6957

ALBERTA ENVIRONMENT
INFORMATION CENTRE
Main Floor
9820 – 106 Street
Edmonton, Alberta
Canada T5K 2J6

Tel: 780.427.2700
Fax: 780.422.4086
Email: env.infocent@gov.ab.ca

ALBERTA ENVIRONMENT
Main Floor,
Petroleum Plaza South Tower
9915 – 108 Street
Edmonton, Alberta
Canada T5K 2G8

Web: www.environment.gov.ab.ca

Figure 10.
Alberta Environment – Regional Contacts

Regional Offices

Northern Region
Peace River
Bag 900 - 5, Provincial Building
9621 - 96 Avenue
Peace River, Alberta T8S 1T4
T: (780) 624-6167
F: (780) 624-6335

Edmonton
Twin Atria
111, 4999 - 98 Avenue
Edmonton, Alberta T6B 2X3
T: (780) 427-7617
F: (780) 427-7824

Central Region
Spruce Grove
Suite 1, 250 Diamond Avenue
Spruce Grove, Alberta T7X 4C7
T: (780) 960-8600
F: (780) 960-8605

Red Deer
3rd Floor, Provincial Building
4920 - 51 Street
Red Deer, Alberta T4N 6K8
T: (403) 340-7052
F: (403) 340-5022

Southern Region
Calgary
Deerfoot Square Building
2938 - 11 Street NE
Calgary, Alberta T2E 7L7
T: (403) 297-7602
F: (403) 297-6069

Lethbridge
2nd Floor, Provincial Building
200 - 5 Avenue South
Lethbridge, Alberta T1J 4L1
T: (403) 381-5322
F: (403) 382-4428

APPENDIX B – WATER-SHORT AREAS

GENERAL

A water-short area is defined as an area (e.g. basin, sub-basin, watershed, aquifer extent) where the cumulative human demand for water meets or exceeds the average natural capability of the source or area to reasonably supply the present or the future needs of water users and the aquatic environment.

CONSIDERATIONS AND CRITERIA

The following considerations describe the basis for identification of water-short and potentially-water-short areas in the Interim Water-short areas map shown in Figure 11. These criteria may also be used in the evaluation of water-short and potentially water-short areas in individual water management plans. Additional criteria may be established to address specific issues in local or basin-scale areas.

1. **Definition of natural supply**

   For the purpose of assessing surface water, the "natural water supply" should be based on the long-term average natural flow as determined by the median annual runoff yield or streamflow volume for a particular watershed or basin, using a minimum record length (20 years). Where natural flows are not available, they must be estimated using regional streamflow records or by using modelled data. Natural subsurface water supply is based on the long-term sustainable use definition for groundwater.

2. **Definition of area**

   "Water-short" areas must be definable and able to be mapped. For surface waters, the watershed is the logical definition and is simple to comprehend. Analysis to the sub-basin level is a practical objective. Sensitivity analysis using GIS mapping may help establish reasonable interim boundaries. Surface catchment boundaries are suitable for surficial groundwater resources. For deeper groundwater, aquifers are the best representation of source, however mapping and defining aquifer extents is, at best, a medium to long-term possibility.

3. **Apportionment and Licensing**

   Areas where 50 per cent of the median annual surface flow is already allocated could be considered short-list candidates for "water-short" status. The reference to median annual flow volume is to ensure apportionment agreement obligations can be met in all years. This definition assumes allocations will be used fully to the maximum licensed amount with no return flows or recycling, which does not recognize the reality or experience of water management in Alberta to date, however this helps ensure that resources are not over-allocated.

   As well, because of geographic and physiographic differences, the inherent risk of being able to meet licensed supply at a given level of allocation is not uniform across Alberta, even if consistent licensing criteria or limits are applied. The concept of risk implies that choosing to allocate or not, or to designate an area as water-short, may have to incorporate business decisions as part of criteria.

   On an interim basis, it may be possible to establish a reasonable level of allocation (as a per cent of median) that can be applied. However, future refinement, based on a watershed management approach, is needed in order to consider differences across basins in the natural variability of supply, the different types of water use and how water is used, reused or returned, the impact of storage and mitigating variability, and individual basin circumstances. Information on basins already closed or restricted is available from AENV. These basins have undergone rigorous evaluation and are candidates for water-short designation.

4. **Environmental and Instream Requirements**

   Ecological considerations and instream flows are increasingly important in determining available supply. Meeting the environmental needs of the aquatic ecosystem (or, not being able to) is an important consideration in defining an area as water-short. In general, defining an area as water-short as a result of environmental/instream criteria results from an over allocation of water intended for human use, where not enough natural flow has been left to meet the IFN.

   Water conservation objectives are a different Tier of instream objective where historic use beyond recognized instream needs has already occurred, and the system is managed to maximize (but not necessarily meet) an instream flow requirement. Note that leaving 50 per cent of flow instream for apportionment purposes also leaves water in the channel that would help meet environmental needs and therefore combined requirements would not necessarily be 100 per cent. (Conversely, if an IFN were established that required more than 50 per cent of flow to be left instream, apportionment requirements would be met simply by adhering to the IFN.)

5. **Growth in demand and future risks**

   Interim "water-short" areas should be based on the average natural flow (refer to Item 1, "Definition of natural supply") plus a reasonable buffer. The long-term process should include quantitative, risk-based analysis of development pressures and variability in water supply (drought risk, climate change).

6. **Combined use/Conjunctive use**

   Interim criteria should combine surface water and groundwater allocations (provincially, licensed groundwater allocation is two per cent of all allocated water), and should follow surface water boundaries. In future definitions and refinements, surface and groundwater supplies within the same area should be considered independently if the ultimate source is established to be different – for example, a deeper aquifer system that is independent of local surface water recharge and/or extends beyond the recognized surface catchment boundary (refer to Item 2, "Definition of area").

7. **"Naturally water-short" areas**

   Some areas in Alberta have naturally low runoff (e.g. the Special Areas). For example, in order for a quarter section to generate enough runoff to meet the statutory household use of 1 acre-foot (1,250 cubic metres), 2 mm of runoff is theoretically required – therefore some watersheds could be considered "water-short" even prior to any development.

OUTCOMES

In considering the above criteria, areas that are not "water-short" or "potentially-water-short" should be able to meet:

- **Apportionment obligations for surface runoff** – apportionment obligations are defined by agreements and are measurable outcomes.
- **Environmental flows of the aquatic ecosystem** – "environmental flows" is a general term that covers instream objectives (IOs) and instream flow needs (IFNs). These are defined and measurable outcomes in basins where they have been derived and applied.
- **Conservation objectives** – these may be applied in basins where it is recognized that IFNs or other management goals are not achievable with current management realities and a conservation objective may be applied as an interim measure with a goal of improving water efficiency.

- **The full allocations of all surface and groundwater licences** – recognizing that some flexibility in interpretation may be necessary in order to account for licensees using less than their full allocation and providing for return flows. Note that in drier years, demand is typically highest (full allocations are more likely to be exercised) when supplies are lowest. Water Use reporting (to be phased in over future years) should provide the necessary information to evaluate this further.
- **Consistency with *Water for Life: Alberta's Strategy for Sustainability*** – Albertans identified priorities for water management in *Water for Life*. Water-short criteria needs to consider the longer-term vision and evaluate future needs in order to sustain a healthy aquatic ecosystem, provide a safe and secure drinking water supply, and ensure reliable quality water supplies for a sustainable economy.

Please refer to Figure 6 on Page 37, which shows an overview of water-short and potentially-water-short areas in Alberta.

Figure 11 outlines the basis for assessment of water-short and potentially-water-short areas based on natural average runoff and administrative limitations on allocation of water resources.

Please refer to Figure 4a on Page 24 and Figure 4b on Page 25. These detailed maps show water-short and potentially-water-short areas based on the interim assessment. Future water management plans will contain more detailed assessments and maps of water-short areas within the area of the respective water management plan or approved water management plan.

Figure 11.

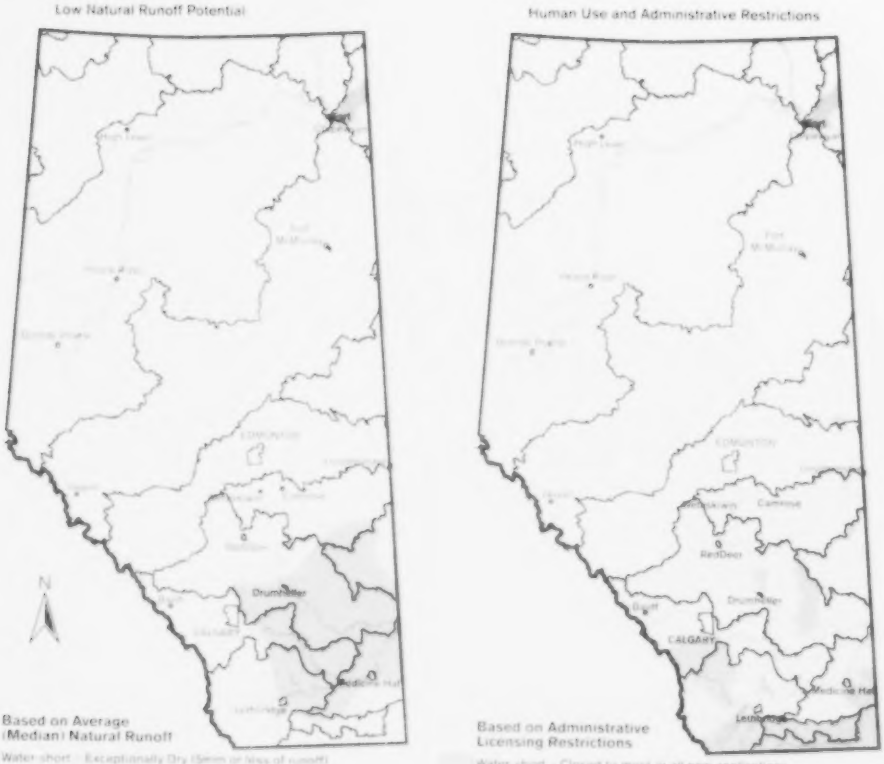
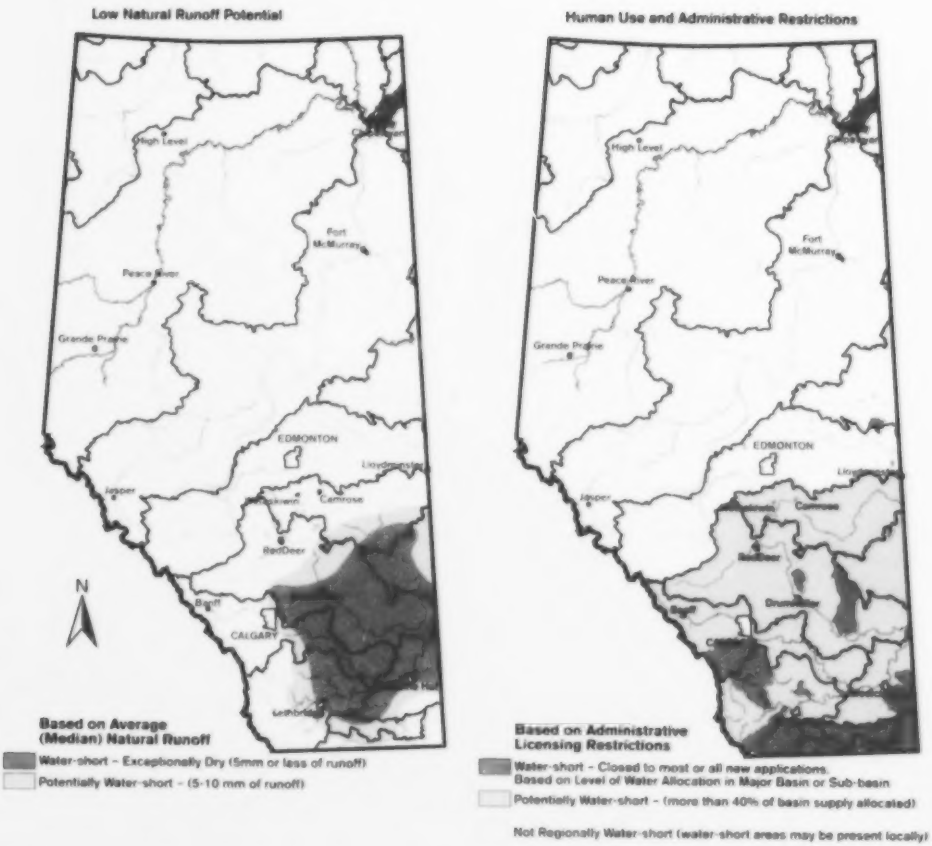

Low Natural Runoff Potential
Human Use and Administrative Restrictions
N
Drumheller
RedDeer
CALGARY
Based on Average (Median) Natural Runoff
Water-short – Exceptionally Dry (5mm or less of runoff)
Potentially Water-short – (5-10 mm of runoff)
Based on Administrative Licensing Restrictions
Water-short – Closed to most or all new applications.
Based on Level of Water Allocation in Major Basin or Sub-basin
Potentially Water-short – (more than 40% of basin supply allocated)
Not Regionally Water-short (water-short areas may be present locally)

Figure 11.
Water Short Areas



The Water Short Areas map is based on two criteria:

1) What is the average natural runoff potential of the watershed or region;
and
2) Based on available natural supply, which areas or watersheds are approaching (or have reached) their limits for reliable water supply?

The two maps shown represent the individual assessment criteria as outlined above.

Note that in any of the buffer zones or in the areas with no coloring, localized concerns with respect to availability of water may still be present. These maps are not a substitute for individual assessments, but serve as a guide to where increased attention is warranted.

APPENDIX C – INFORMATION SOURCES

C.1 GENERAL INFORMATION SOURCES

Alberta Environment
www.environment.gov.ab.ca

Alberta Energy
Utilities Board
www.eub.gov.ab.ca

C.2 LEGISLATION

WATER ACT (CH W-3, RSA 2000)
WATER (MINISTERIAL) REGULATION (REG. 205/98)
www.qp.gov.ab.ca

EUB REGISTRATION

ALBERTA ENERGY AND UTILITIES BOARD ACT
(CH.A-17, RSA 2000)

ENERGY RESOURCES CONVERSATION ACT
(CH E-10, RSA 2000)

OIL AND GAS CONSERVATION ACT
(CH.O-6, RSA 2000)

OIL AND GAS CONSERVATION REGULATIONS
(AR 390/2003)

OIL SANDS CONSERVATIONS ACT

OIL SANDS CONSERVATION REGULATION
(AR 191/2003)
www.eub.gov.ab.ca

C.3 EUB GUIDELINES

Guide 23 – Guidelines Respecting an Application for a Commercial Crude Bitumen Recovery and Upgrading Project
(EUB, SEPTEMBER 1991)
This guideline sets out requirements and procedures needed to prepare an application for development of a commercial-scale oil sands mine, or in-situ development using steam injection.

Guide 51 – Injection and Disposal Wells: Well Classifications, Completion, Logging, and Testing Requirements
(EUB, MARCH 1994)
This guideline specifies waste classification requirements, well construction and monitoring requirements, and safety measures regarding the underground disposal of liquid industrial and oilfield wastes.

Directive 65 – Resources Applications for Conventional Oil and Gas Reservoirs
(EUB, REVISED JUNE 2003)
This guideline specifies procedures and industry practices required for licensing and operating conventional oil and gas recovery operations in Alberta. This includes applications for ER Schemes.

IL 89-5 Water Recycle Guidelines and Water Information Reporting for In Situ Oil Sands Facilities in Alberta
(INFORMATIONAL LETTER, EUB, MAY 1989)
This information letter outlines government expectations, objectives and requirements for recycling water used in steam injection (for recovery of bitumen from oil sands deposits).

C.4 AENV GUIDELINES

Water Conservation and Allocation Policy for Oilfield Injection (2006)
(AENV 2006)
This Policy encourages water conservation for oilfield injection in Alberta, in conjunction with this Guideline, and sets overall policy direction for the use of water in enhanced recovery operations.

Groundwater Evaluation Guideline
(AENV 2003)
This technical Guideline specifies procedures and practices for evaluating and protecting groundwater resources. The Guideline is used in preparation of *Water Act* applications (for licences to use non-saline groundwater in Alberta).

APPENDIX D – SUSTAINABLE RESOURCE ENVIRONMENTAL MANAGEMENT SYSTEM FOR OILFIELD INJECTION WATER USE

Water for Life: Alberta's Strategy for Sustainability emphasizes improved leadership in water conservation as one of the key directions essential to achieving long-term goals of a sustainable future. The strategy states:

> *Water conservation, combined with a focus on getting the most production possible from the water that is already allocated, is a fundamental component of any provincial water strategy.*
>
> *Because citizens, communities, industries and governments all share responsibility for the wise use and sustainability of water, and building on the partnership approach all Albertans will need to take responsibility and take actions in the area of water conservation.*

Alberta's Commitment to Sustainable Resource and Environmental Management[28] provides direction regarding environmental protection during the development of natural resources in Alberta.

The "systems approach" adopted in the chart found on page 7, (Figure 2) emphasize the leadership role expected of the oil and gas industry and regulatory agencies in achieving significant conservation gains with regard to the use of non-saline water.

27 *Water for Life: Alberta's Strategy for Sustainability*, Key direction: Water Conservation, page 21.
28 *Alberta's Commitment to Sustainable Resource and Environmental Management* is available at: www.gov.ab.ca/srd/info/sustainable.pdf

APPENDIX E – EVALUATION OF PROJECT SCALE

The project scale of an enhanced recovery project (the amount of oil produced and water injected) has an impact on the feasible water conservation measures that can be used during the project. Large-scale projects can afford more extensive evaluation and water conservation measures, and have larger environmental impacts locally and cumulatively relative to small ER projects.

Figures 12 and 13 displays a graphic analysis of water allocation and water use in 2001. This analysis demonstrates the numbers of projects, and the proportion of water use, that may occur in Tier 1, Tier 2, and Tier 3 projects in Alberta. In general, it is anticipated that approximately 80 per cent of the ER projects are small-scale and will generally be classified as Tier 1, except in water-short and potentially-water-short areas of Alberta. These projects account for approximately 20 per cent of water use. Large-scale projects (Tier 2 or Tier 3) account for more than 80 per cent of non-saline water use for oilfield injection in Alberta.

Figure 12.
Range of project water use 2001

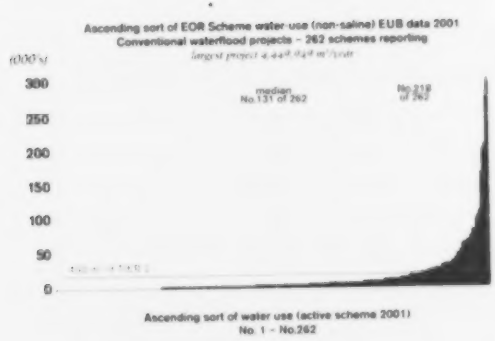
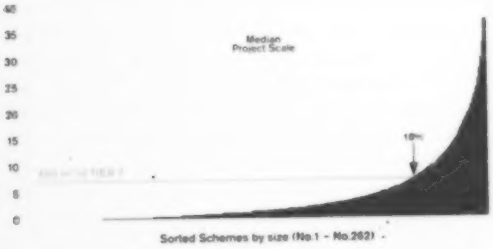


Figure 13.
Cumulative water use in 2001, arranged by project scale.



APPENDIX F – GLOSSARY

ACRONYMS

AENV	Alberta Environment
AERI	Alberta Energy Research Institute
AFE	Authorization For Expenditure
APEGGA	Association of Professional Engineers, Geologists, and Geophysicists of Alberta
AWC	Alberta Water Council
CAPP	Canadian Association of Petroleum Producers
CONRAD	Canadian Oil Sands Network for Research and Development
EPEA	Environmental Protection and Enhancement Act
EAB	Environmental Appeals Board
EOR	Enhanced Recovery (scheme, method)
EIA	Environmental Impact Assessment (see environmental assessment)
EUB	Energy and Utilities Board
IFN	Instream-Flow-Needs (see instream flows)
NPV	Net Present Value
PTAC	Petroleum Technology Alliance of Canada
SOE	State of the Environment
SREMS	Sustainable Resource Environmental Management System
WPAC	Watershed Planning and Advisory Council

ADAPTIVE MANAGEMENT – Project management that plans contingencies and actions to address uncertainty in environmental impacts, and variability in environmental conditions. Conjunctive use of surface and groundwater, and reduced water use in drought periods are examples of adaptive management of water resources.

ALBERTA WATER COUNCIL – A provincial advisory body including industrial sector representatives, established to provide advice to the Government of Alberta regarding water issues.

ALLOCATION – When water is permitted to be redirected for a use other than for domestic purposes, it is referred to as an allocation. Agricultural, industrial and municipal water users apply to AENV for a licence to use a set allocation of water. This water licence outlines the volume, rate and timing of a diversion of water.

APPORTIONMENT AGREEMENT – An inter-provincial o international agreement specifying the sharing of water resources from trans-boundary sources. Alberta and Saskatchewan share the resources of t North and South Saskatchewan Rivers through apportionment agreements.

APPROVALS MANAGER – An AENV administrative position responsible for issuing *Water Act* licences within a specified area of Alberta.

APPROVED WATER MANAGEMENT PLAN – A water management plan that is approved under part 2 of the *Water Act (RSA 2000, W-3, s. 11)*.

AQUATIC ENVIRONMENT – (As defined in the *Water Act*) The components of the earth related to, living or located in or on water or the beds or shores of a water body including, but not limited to, all organi and inorganic matter, and living organisms and the habitat, including fish habitat, and their interacting natural systems.

AUTHORIZATION FOR EXPENDITURE – An economic evaluation standard used in the oil and gas industry (described in Section 3.2.4).

BITUMEN – Best described as a thick, sticky form of crude oil, so heavy and viscous that it will not flow unless it is heated or diluted with lighter hydrocarbons. At room temperature, it is much like molasses.

CONSERVATION – includes but is not limited to:

(i) improved efficiency, recycling, reuse or reduction of wastage or losses;

(ii) preservation; and

(iii) protection.

CONTINGENCY MEASURES – Water management measures designed to meet environmental and wat supply needs under adverse conditions (e.g. drough contingency measures).

CONJUNCTIVE USE – The use of more than one water source, systematically, to reduce overall environmental impacts. An example is the use of groundwater resources during drought periods, replacing the use of surface water sources available during periods of abundant surface runoff.

CUMULATIVE EFFECTS – The combined effects on the aquatic environment or human developments arising from the combined environmental impacts of several individual projects.

CONSUMPTIVE USE – The balance of water taken from a source that is not entirely or directly returned to that source. For example, if water is taken from a lake to feed cattle, it is considered a consumptive use of water. In contrast, hydroelectric power generation is a non-consumptive water use.

CONTINUOUS IMPROVEMENT – The process of achieving long-term desired outcomes through plan-act-review cycles of technical innovation and adaptation.

DECISION TREE – A process flow diagram describing actions and decisions needed to complete a design process or regulatory process (see Figures 3 and 5).

DESIGNATED DIRECTOR – (see Approvals Manager) An AENV administrator with authority designated under the *Water Act*.

DISCOUNT RATE – A rate used to compare the value of a dollar received in the future to a dollar received today.

DISPOSAL WATER – Produced water from oil, gas and crude bitumen production that is injected into deep underground formations approved for disposal by the EUB.

ENERGY AND UTILITIES BOARD (EUB) – The EUB is a provincial quasi-judicial, independent body created by the Government of Alberta to ensure energy resources are developed responsibly and to ensure optimum recovery of the province's oil, gas, and crude bitumen resources.

ENVIRONMENTAL NET EFFECTS – The comparison of overall environmental risks and benefits of alternative water sources (see Section 3.2.6).

DIRECTLY AFFECTED PERSON – A person whose personal interests are affected or potentially affected by the water diversion proposed in a water licence application. Directly affected persons have special rights and responsibilities under the terms of the *Water Act*.

DRAWDOWN – The reduction in water level in a water well when the pump is operating.

ENHANCED RECOVERY (ER) – A process in which a substance, typically water (saline, non-saline, produced or recycled), is injected into oil reservoirs to increase and maintain the reservoir pressure so more oil can be extracted. The two main types of enhanced oil recovery are water flooding, in which water is pumped into conventional oil field reservoirs, and injection of steam into heavy oil deposits. Enhanced oil recovery operations do not include oil sands mining operations.

ENVIRONMENTAL APPEALS BOARD (EAB) – An independent board established by the Government of Alberta to hear appeals, as mandated by the *Environmental Protection and Enhancement Act* and the *Water Act*.

ENVIRONMENTAL ASSESSMENT – A formal review of the impacts of a proposed development project to support the goals of environmental protection and sustainable development, as required by the *Environmental Protection and Enhancement Act*.

ENVIRONMENTAL FLOWS – (see "instream needs")

ENVIRONMENTAL STEWARDSHIP – A "culture of stewardship" to achieve environmental protection, and sustainable development, with minimal environmental impacts.

ER SCHEME APPROVAL – A regulatory approval issued by the EUB for a conventional or thermal enhanced recovery project.

GREEN AREA (GREEN ZONE) – The forested lands of northern Alberta and the Eastern Slopes that are not available for agricultural development, other than grazing.

INSTREAM NEEDS/INSTREAM FLOW NEEDS (IFN) – Scientifically determined amount of water, flow rate or water level or water quality required in a river or other body of water to sustain a healthy aquatic environment. Comprehensive IFN determinations typically consider water quantity, water quality, aquatic habitat and aquatic species. Instream needs or IFNs can also be established for other purposes (e.g. to meet human needs such as recreation, navigation, waste assimilation, or aesthetics).

INTERIM WATER-SHORT AREA MAP – *(See Appendix B)* A map of areas of Alberta where water is potentially in short supply due to low natural precipitation, or increasing development pressure.

LICENCE CONDITIONS – Requirements of *Water Act* diversion licences that specify monitoring and reporting, time and volume specifications of diversions, and site specific or project restrictions.

LICENCE RENEWAL – A process specified in the *Water Act* for review and continuation of a term water diversion licence.

LICENCE TERM – The length of time for which an allocation of water is granted under a *Water Act* licence. The term varies for oilfield injection (initially two years, subsequently five year renewable terms).

LONG-TERM YIELD – The expected sustainable yield of a well over a 20 year period (neglecting aquifer recharge) in accordance with the AENV *Groundwater Evaluation Guideline*[29]

NET PRESENT VALUE (NPV) – The present discounted value of expected future cash flows from an investment, less cost of the investment. This is done by assigning monetary values to benefits and costs, discounting future benefits and costs using an appropriate discount rate, and subtracting the sum total of discounted costs from the sum total of discounted benefits.

NON-SALINE WATER – Water with less than 4,000 mg/L of total dissolved solids. Often referred to as fresh water.

OILFIELD INJECTION – Processes in which water, with or without another injectant (hydrocarbon solvent or CO_2), is injected through wells into conventional hydrocarbon reservoirs to increase or maintain the reservoir pressure so that hydrocarbon recovery is increased. Oilfield injection also includes processes in which water is injected as steam through well(s) into oilsands deposits or conventional heavy oil pools to lower the viscosity of the crude bitumen so it can flow to a production wellbore.

OFFSETS – Innovative water supply improvement or replacement options at other projects that can mitigate the impacts of an oilfield injection use of non-saline water.

29 www.gov.ab.ca/env/water/Legislation/Guidelines/GroundwaterEvaluation.pdf.

PERMANENT LICENCE – A water diversion licence issued in perpetuity (no specified term) under the *Water Resources Act* (i.e. prior to 1999).

PILOT PROJECT – A pre-commercial, small-scale demonstration project conducted to confirm technical and economic factors of a proposed resource development project.

POTENTIALLY-WATER-SHORT AREA – An area considered relatively dry (low natural runoff) or where the watershed has a high level of allocation compared to natural supply.

PRODUCED WATER – Water that is produced with hydrocarbons (oil, gas, and crude bitumen) from a well. Produced water is separated from the oil and gas and is measured and reported to the EUB. Produced water volumes from every oil and gas production well are included in the EUB Production Injection Database. Also referred to as "Disposal water."

PRIMARY RECOVERY – Oil flows or is pumped to the surface from an oil pool without using any injectant.

RECYCLED WATER – Water that is re-used for conventional water flooding (or thermal ER steam injection) after recovery with hydrocarbons from production wells.

RESOURCE EFFICIENCY – The volume of water use compared to the volume of oil (hydrocarbons) produced.

SALINE GROUNDWATER – Groundwater that has more than 4,000 mg/L of total dissolved solids (TDS).

SECONDARY RECOVERY – Also known as waterflooding, injecting water into the oil pool to maintain pressure and displace oil.

STATEMENT OF CONCERN – A written objection to a *Water Act* licence application, made under the *Water Act (RSA-2000, W-3, s.109)*.

SUSTAINABLE RESOURCE ENVIRONMENTAL MANAGEMENT SYSTEM (SREM) – A systems approach to managing environmental issues to achieve defined environmental outcomes (see Appendix D).

TERTIARY RECOVERY – Includes methods or techniques used to increase the amount of oil recovered, after primary oil recovery (initial flow or pumping) and secondary recovery (waterflooding). Hydrocarbon miscible flooding (injection of petroleum solvents), CO^2 injection, VAPEX and other advanced techniques are "tertiary" recovery methods. Secondary and Tertiary recovery are together referred to as "enhanced recovery."

TIER 1 – The lowest level classification of environmental risk (see Section 3.2).

TIER 2 – The middle Tier of the risk classification system (see Section 3.2).

TIER 3 – The highest risk classification category (see Section 3.2).

TERM LICENCE – A water diversion licence issued under the *Water Act* for a specified term (two to five years for ER projects).

WATER CONSERVATION OBJECTIVE – An amount and quality of water needed to meet the objectives for protection of the aquatic environment, fisheries, tourism and other needs as set out in Part 2 of the *Water Act*.

WATER FLOODING – A conventional enhanced recovery process in which water is pumped into a well to maintain the reservoir pressure so hydrocarbon recovery is enhanced. Also referred to as "Secondary Recovery."

WATERSHED – The area of land that catches precipitation and drains into a larger body of water such as a marsh, stream, river or lake.

WHITE AREA (WHITE ZONE) – The settled regions where agriculture is the most significant land use, including the grasslands and parklands of southern and central regions, and the Peace Country in the north.

WATER MANAGEMENT PLAN – A plan to conserve and manage water developed under the *Water Act (RSA 2000, W-3, s. 9)*.

WATERSHED PLANNING AND ADVISORY COUNCIL – An advisory committee established to advise AENV on water management issues while developing a Water Management Plan, and/or to provide advice and direction during the long-term implementation of a Water Management Plan.

WATER-SHORT AREA – An area where natural conditions and/or development pressures limit the availability of surface water and groundwater for future sustainable development and protection of the aquatic environment. (See Section 3.2.8, and Appendix B).

Save-A-Tree

Paper goes a long way.

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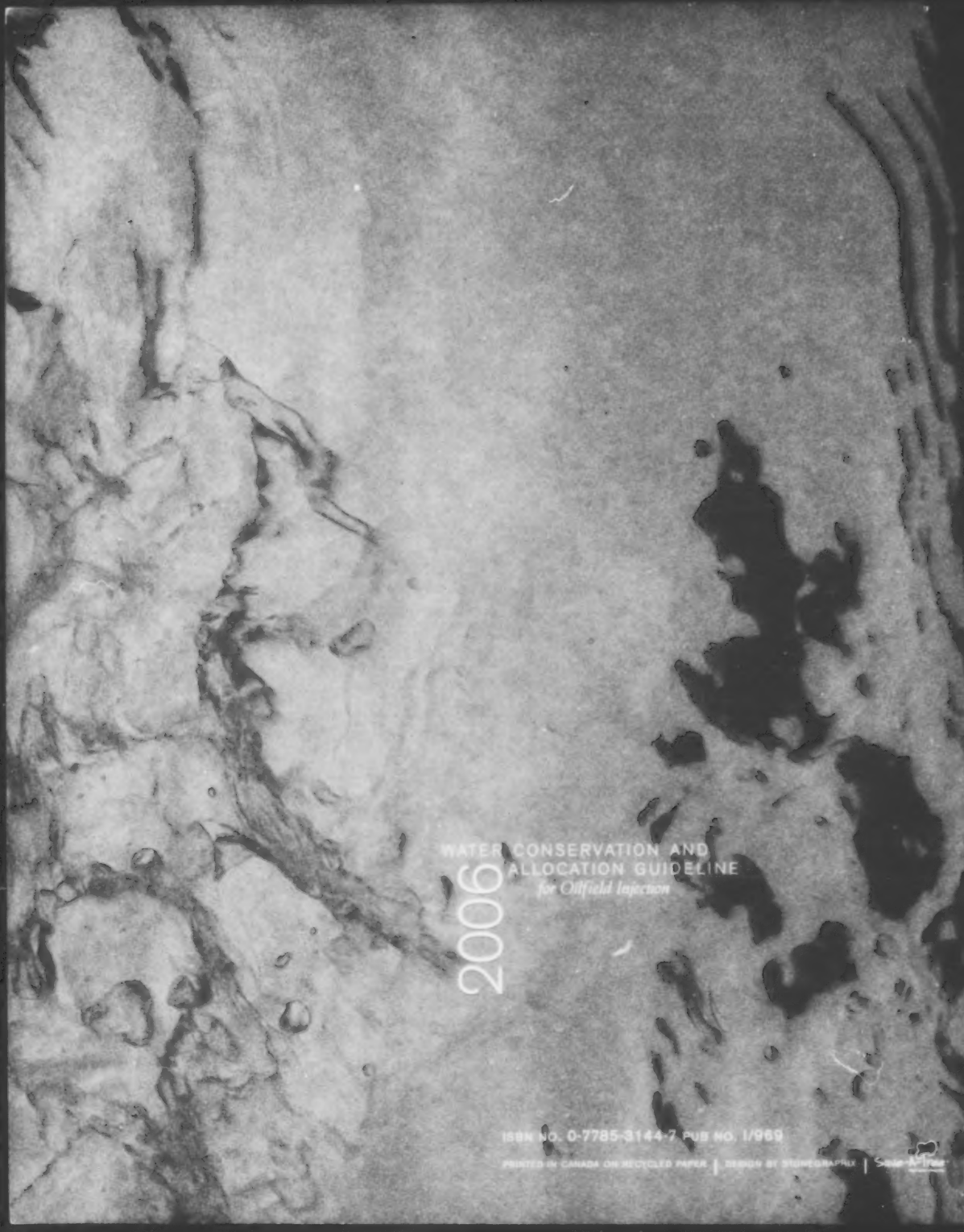

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